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PAPERS PRESENTED AT

NEW MEXICO OIL CONFERENCE

May 5th and 6th, 1939

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THE UNIVERSITY OF NEW MEXICO BULLETIN

Whole Number 343 May 1, 1939
Geological Series, Volume 5, No. 3

Published monthly in January, March, May, July, September, and November, and semi-monthly in February, April, June, August, October, and December by the University of New Mexico, Albuquerque, New Mexico

Entered as Second Class Matter, May 1, 1906, at the post office at Albuquerque, New Mexico, under Act of Congress of July 16, 1894

UNIVERSITY OF NEW MEXICO PRESS
1939

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New Mexico Taxpayers Association, Santa Fe

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   Dr. V. C. Kelley, Assistant Professor of Geology, University of New Mexico

   C. P. Miller, Geologist, Hobbs

2. Financial and Economic Stake in Oil
   Hugh L. Sawyers, Tax Agent, New Mexico Oil and Gas Association

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3. Oil Industry in School Finance
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2. New Mexico's Conservation Achievements
   Hiram M. Dow, New Mexico Representative, Interstate Oil Compact Commission, Roswell

   DISCUSSION
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3. A Sound Oil Conservation Program
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   DISCUSSION
   - Hugh M. Stalcup, Vice-president, Skelly Oil Company, Tulsa, Oklahoma
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   - Van S. Welch, Artesia

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ADDRESS—INTERSTATE COMPACTS AND THE OIL INDUSTRY

W. R. Boyd, Jr., Executive Vice-president, American Petroleum Institute, New York, New York

OIL AND GAS DEVELOPMENT IN NEW MEXICO

By A. ANDREAS [1]

EARLY HISTORY

More than half a century ago the United States Geological Survey reported as follows on the first known attempt to develop commercial production of petroleum in New Mexico.[2] "In April the New Mexico Bitumen and Oil Company, while prospecting within six miles of the eastern border of the Navajo reservation, and in the extreme western portion of New Mexico, discovered a flowing oil spring; but the workmen were driven away by Navajoes before they could determine the quantity of oil obtainable. The quality of the crude petroleum is excellent, and the value of the strike will very shortly be fully investigated."

According to Joseph D. Weeks: [3] "Information has been received of a very small production of a heavy lubricating oil in Bernalillo (now McKinley) County on section 11, township 16 north, range 16 west. This oil flows naturally from the rocks containing it. The product is stated to be a barrel a day, which is probably in excess of the actual production. It is sold in small quantities to consumers in the immediate vicinity at the rate of $10 a barrel. The larger proportion of the production is wasted and lost. It is also reported that there are several places on the Navajo Indian Reservation where petroleum exudes in a similar manner from the crevices in bituminous sandstone, and there is no doubt that at many places in New Mexico the same phenomena that are noticed in Colorado and Wyoming will be found to exist."

Evidences of oil seeps were early reported from localities in Colfax, Eddy, Guadalupe, Lincoln, Otero, San Juan, and Union counties. Governor Miguel A. Otero, in his report to the Secretary of the Interior for the year 1902, mentioned the saturated sandstone about eight miles north of Santa Rosa and stated that capital was interested in prospecting for oil in that vicinity. In New Mexico, as in other states, oil shows have been encountered frequently in wells drilled for water.

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[1] State geologist and member Oil Conservation Commission.

[2] Williams, Albert, Jr., Petroleum: Mineral Resources U. S., 1882, p. 212, 1883.

[3] Mineral Resources U. S., 1889 and 1890, p. 365, 1892.

Active search for petroleum in southeastern New Mexico dates from about 1908, and, in 1914, Richardson[4] reported: "The best yield of petroleum yet obtained in the Pecos Valley is from the old Hammond, now known as the Brown well, in the NE. ¼ sec. 15, T. 18 S., R. 26 E., 2¼ miles northeast of Dayton. This well was sunk in 1909 to a depth of 950 feet. A flow of water was encountered at 660 feet, a little gas at 762 feet, and oil between 911 and 926 feet. An attempt was made to case off the flow of water, and in the summer of 1911 a yield, continuing for several months, of 6 to 10 barrels of oil a day was reported. In 1912 this well was acquired by Charles S. Brown, of Artesia, who succeded in increasing the yield of oil and in cutting off more water, but the attempt to case off the water has been only partly successful. In March, 1919, Mr. Brown stated that he pumped approximately 800 barrels of liquid a day from this well, including about 25 barrels of oil. The oil is separated from the water by a series of settling tanks and is sold for fuel and for smudging orchards."

About this time prospecting for commercial quantities of oil and gas was being pushed in northwestern New Mexico in the general area mentioned by Williams in 1883. Gregory[5] reports: "In sinking a well for water in sec. 18, T. 18 N., R. 10 W. New Mexico principal meridian, Henry F. Brock unexpectedly found a considerable amount of gas and some oil. As a result 3,000 claims were located in twenty townships near by, and drilling on a moderate scale was begun. By the end of 1912 oil with gas had been found in six wells, in quantity not sufficient to justify exploitation on a commercial scale, and in 1913 the field was practically abandoned. The petroleum was encountered between 350 and 600 feet below the surface and, so far as known, in strata of the Mesaverde formation, which, in this locality, dip to the north and northwest at an average angle of about 2°."

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[4] Richardson, G. B., Petroleum near Dayton, New Mexico: U. S. Geol. Survey Bull. 541, p. 136, 1914.

[5] Gregory, Herbert E., Geology of the Navajo Country—a reconnaissance of parts of Arizona, New Mexico, and Utah: U. S. Geol. Survey Prof. Paper 93, p. 145, 1917.

From the above extracts it will be noted that the presence of oil in various parts of New Mexico has been known for more than fifty years. However, it took forty years of pioneering before the first commercial oil well was completed.

RECENT DEVELOPMENTS

The first commercial well, either oil or gas, in the state was the Midwest Refining Company's No. 2 well in Sec. 36, T. 32 N., R. 14 W., San Juan County, in what is now known as the Ute Dome gas field. This well was bottomed in the Dakota sandstone at a depth of 2,428 feet, and was completed in June, 1922. Its initial production was 37,000,000 cubic feet of gas daily.

Disregarding the small oil well (Hammond, or Brown) drilled in 1909 in Eddy County, the first commercial oil well in this state was the Midwest Refining Company's discovery on the Hogback structure in San Juan County. This well came in with an estimated original flow of 375 barrels of high-gravity oil a day from the Dakota sandstone of Cretaceous age and from a depth of 796 feet. The well was completed September 25, 1922. The second oil field discovered in New Mexico was the Rattlesnake Field, also in San Juan County. The discovery well on this structure was completed February 27, 1924, after it had been drilled to a depth of 821 feet.

The first commercial oil production in the southeastern part of the state was discovered by Flynn, Welch, and Yates when they completed their No. 3 well on April 9, 1924. This well was located in Sec. 32, T. 18 S., R. 28 E. It reached a depth of 1,947 feet and had an initial production of fifteen barrels of oil a day. The first two wells drilled by Flynn, Welch, and Yates encountered some gas and oil but the No. 3 well attracted considerable attention and encouraged operators to acquire acreage in this vicinity. The ensuing drilling by various companies and individuals rapidly developed what is now known as the Artesia field. It is interesting to note that the first oil royalty check received by the state of New Mexico was from Flynn, Welch, and Yates, dated July 2, 1924, for the sum of $125.

Recent drilling in Eddy County has developed important production from the Yates (Capitan) sand at a depth of approximately 2,800 feet.

The first commercial well completed in Lea County was the Texas Production Company's Rhodes No. 1, located in Sec. 22, T. 26 S., R. 37 E. This well was completed November 1, 1927, after it had reachd a total depth of 3,213 feet. The initial production of the well was 300 barrels of oil accompanied by 22,500,000 cubic feet of gas. This oil has an asphaltic base, a gravity of 35° A. P. I., and a sulphur content of 1.71 per cent. The Rhodes No. 1 was the discovery well of the Jal area and is in what is now known as the Rhodes field.

On October 12, 1927, the Midwest Refining Company started its State No. 1 well in Sec. 9, T. 19 S., R. 38 E., after a magnetometer survey had indicated the presence of a favorable structure. This well was completed April 25, 1929, after having penetrated the Permian "Big Lime" and reaching a total depth of 4,245 feet. The initial production of this well was 700 barrels of oil daily, and it was the discovery well of the area now known as the Hobbs pool.

Before any more wells were completed in this area the Humble Oil and Refining Company spudded its No. 1 Bowers in Sec. 30, T. 18 S., R. 38 E., approximately three miles northwest of the discovery well. This Humble well was completed February 6, 1930. Its initial production was 7,632 barrels of oil daily and it reached a total depth of 4,215 feet. The discovery of the Hobbs pool attracted the attention of the oil operators to the possibilities of Lea County and in a short time the Eunice, Cooper, and Lynch pools were brought in.

The first pipe line to provide an outlet for Hobbs oil was completed in May, 1930, by the Humble Pipeline Company. In July, 1930, the Atlantic and Shell companies completed their lines.

The acidizing of wells to increase production was introduced in the early part of 1933 by the Atlantic Production Company. The results obtained were extremely satisfactory and it became common practice to acidize nearly all the wells completed. The acidizing of these wells increased their initial daily production by as much as several thousand per cent.

The Hobbs Field furnishes an outstanding example of controlled production. Here the bottom hole pressure has declined less than three pounds for each million barrels of oil produced.

In July, 1929, the Magnolia Petroleum Company completed its State Bridges No. 1 on the section line between Sec. 13 and 14, T. 17 S., R. 34 E., in the Vacuum field. This well was drilled to 4,900 feet and its initial production was reported to have been 105 barrels of oil daily without acidizing. This well is on the north edge of the proven area of the Vacuum pool.

After the discovery of the Eunice, Cooper, and Lynch pools, in 1930, there was an interval of five years before the discovery of another major oil pool in New Mexico.

The Monument pool was discovered March 16, 1935, when the Amerada Petroleum Company's State "D" No. 1, Sec. 1, T. 20 S., R. 36 E., came in. This well was drilled to a depth of 3,945 feet and, after being acidized, its initial production was 3,552 barrels of oil and 2,100,000 cubic feet of gas daily.

The oil produced in the Cooper, Eunice, Hobbs, Lynch, and Monument fields comes from the "Big Lime" in the Permian San Andres formation.

East of these fields important sand production has been developed in the Hardy, Langlie, Mattix, Penrose, and Skelly pools. This sand is stratigraphically higher than the "Big Lime."

THE OIL AND GAS FIELDS OF NEW MEXICO

San Juan Basin, Northwestern New Mexico

There are six oil fields and three gas fields in the San Juan Basin. The most important producing horizon in this area is the Dakota sandstone (basal member of the Upper Cretaceous), which is encountered at a comparatively shallow depth. Production is also obtained from the Farmington sandstone, e. c., which is also Cretaceous but which is stratigraphically higher than the Dakota. This latter sand is lenticular and the wells penetrating it are very small and get their production from minor folds in the syncline. Two deep wells, drilled on the Rattlesnake structure, obtained commercial production from Upper Pennsylvanian rocks at a depth of approximately 6,800 feet. This is the only oil production from Pennsylvanian rocks that has thus far been found in New Mexico. This oil has a gravity of 40° A. P. I. The oil from the Dakota sandstone has a gravity of approximately 60° A. P. I. and contains about .08 per cent sulphur.

Although there are several small refineries in the San Juan area, oil from the Rattlesnake field is transported through a four-inch line to Gallup, 96 miles south. This oil is then shipped in tank cars to a refinery in Albuquerque, New Mexico.

The gas from Ute Dome is transported through a six-inch line to Durango, Colorado. The Kutz Canyon gas field supplies the cities of Albuquerque, Bernalillo, and Santa Fe through a twelve-inch line. Gas for local consumption comes from one well in the small Blanco field.

On the southern edge of the San Juan Basin, important production has been developed during the past year from the Hospah Dome in Tps. 17 and 18 N., R. 9 W., McKinley County.

Commercial production was first discovered here in 1927 but there was no outlet for the oil at that time. The oil now being produced is hauled from the wells in trucks. In the Red Mountain field, also in McKinley County and in T. 20 N., R. 9 W., several wells producing five to ten barrels daily have been drilled recently. This oil has a gravity of 42° A. P. I. and comes from the Mesaverde group.

There are several untested and undeveloped structures on the western edge of the San Juan Basin. On the eastern edge of the basin there are several folds which have not been drilled, but there is no reason to believe that oil in commercial quantities does not exist in this area.

Permian Basin, Southeastern New Mexico

Eddy County

There are eleven producing oil and gas fields in Eddy County. The oil obtained is a sweet crude having a weighted average gravity of 37° A. P. I. Eddy County has been and still is handicapped by lack of pipelines. Gas encountered is used to some extent for development within the fields but a considerable quantity is sold in Artesia and other points in the Pecos Valley. In the Pecos Valley there are a number of small oil refineries the products from which find a ready market in the state and in Arizona. The Getty pool, southeast of Artesia and in T. 20 S., R. 29 E., produces an asphaltic base oil having a gravity of 21° A. P. I. This oil is used exclusively for the construction of roads.

Important production was developed from the "Artesia Red Sand" in the Shugart and Loco Hills areas, Eddy County, during the past year.

Lea County

At the first of this year there were eighteen producing fields in Lea County, all the oil coming from the Upper Permian San Andres limestone and the "Yates Sand." The oil from the limestone is sour, and that from the sandstone is sweet. The average depth of the producing wells is 3,300 feet in the Eaves area in the extreme southeastern part of the state, and is progressively greater northward to the Vacuum field, where the average is 4,688 feet. None of the oil produced in Lea County is refined in New Mexico but is transported outside the state through pipelines having a daily capacity of approximately 142,000 barrels. For the first four months of 1939 the daily pipeline runs of oil from Lea County averaged 105,383 barrels.

Gas produced in the Lea County fields is used locally for field development and for domestic purposes, and is transported outside the state. The El Paso Natural Gas Company takes New Mexico gas through a 16-inch line to El Paso, Texas. From El Paso the gas is piped to several communities in southern New Mexico, to several points in Arizona and to Chihuahua and Sonora, Mexico.

Six plants have been erected for the extraction of the gasoline content of the gas. These plants have a combined capacity of 235,000 gallons of gasoline a day. The heat value of the gas varies from 1,000 to 1,100 BTU's a cubic foot. The gas from the Hobbs field contains approximately 1.42 gallons of gasoline in each thousand cubic feet and the gas from the Monument field averages about 0.73 gallons. Some of the gas used by the gasoline plant is re-cycled and used for 43-pressuring wells in the Hobbs pool. There is a small skimming plant of 100 barrels daily capacity located at Hobbs.

Carbon Dioxide, Northeastern New Mexico

Within the last few years carbon dioxide has been found in commercial quantities in Harding, Mora, Torrance, and Union counties. In Torrance County, the Witt Ice and Gas Company has been manufacturing solid carbon dioxide, commonly known as "dry ice," for several years. This plant has a daily capacity of thirty tons. In Harding County there have been twelve commercial wells drilled. The gas is approximately 98 per cent pure carbon dioxide in both fields. Two small plants have been completed in the Bueyeros field, Harding County, but the output is negligible. A large plant for making solid carbon dioxide from the Harding County gas is now under construction at Solano, on a branch line of the Chicago, Rock Island and Pacific railroad. This plant will be connected with the wells near Bueyeros, eighteen miles due east, by a pipeline which is nearly completed.

The manufacture of solid carbon dioxide is a comparatively new industry in New Mexico and will, in time, prove to be a valuable asset to the state.

OIL AND GAS CONSERVATION IN NEW MEXICO

Soon after commercial quantities of oil were found in Lea County the operators and producers voluntarily formed the "Hobbs Operators Agreement." This agreement took effect July 10, 1930, and C. G. Staley, former state geologist, was chosen as proration umpire. With some variations, the operators in all fields since discovered have followed a proration program similar to that outlined in the original Hobbs agreement.

During the legislative session of 1935 Senate Bill No. 79 was introduced and passed. In general, the bill provided for the conservation of oil and gas in New Mexico and created an Oil Conservation Commission composed of the governor, the commissioner of public lands, and the state geologist. Section 10, Senate Bill No. 79, provided, in part:

Included in the power given to the commission is the authority: to collect data, to make investigations and inspections; to examine properties, leases, papers, books, and records; to examine, check, test, and gauge oil and gas wells, tanks, plants, refineries, and all means and modes of transportation and equipment; to hold hearings; to provide for the keeping of records and the making of reports, and for the checking of the accuracy thereof; to limit and prorate production of crude petroleum oil and natural gas; to require either generally or in particular areas certificates of clearance or tenders in connection with the transportation of crude petroleum oil or any products thereof, or both such oil and products.

One of the requirements of the commission is that only one commercial oil or gas well may be drilled on a forty acre tract. Exceptions to this rule must be acted upon by the commission.

Considerable remedial work in reducing excessive gas-oil ratios has been accomplished through coöperation of the operating companies with the Oil Conservation Commission.

From time to time criticism has been directed against the Oil Conservation Commission for holding down the daily production for the state. There are various reasons why this relatively low production has been maintained. First, it is contrary to good conservation practice to allow unrestricted flow of oil from any field; second, controlled production will ultimately bring the greatest yield per acre; and third, the market demand is lower than the potential production. The Oil Conservation Commission has endeavored and succeeded in keeping the production within and even below the United State Bureau of Mines recommendations.

The maintenance of the Oil Conservation Commission is provided for as follows by Section 25, Senate Bill No. 79:

"There is hereby levied a tax of one-eighth of one per cent on the proceeds of all oil and gas produced in this state, except royalties payable to the United States or to this state."

New Mexico is well aware of the importance of the oil industry to the state, and the New Mexico School of Mines, located at Socorro, established courses in petroleum geology and technology several years ago. At the present time, the School of Mines, with the assistance of the federal government, is erecting a new building which will be devoted exclusively to the study of petroleum and natural gas. The latest and most modern equipment has been ordered for this building. Several oil companies have donated machinery and drilling equipment and it is anticipated that these donations will be greatly increased when this building is completed.

The New Mexico School of Mines ranks fourth among the mining schools of the United States. Its graduates have established excellent reputations and are very much in demand by the various oil companies. Students from the New Mexico School of Mines are now working in responsible positions in nearly all the oil producing countries of the world.

The school, through its State Bureau of Mines and Mineral Resources, maintains a well log division, where the logs of more than 3,500 wells are kept on file. These logs are completely indexed by section, township, and range, by company and lease, and by county.

SUMMARY AND CONCLUSIONS

In the northeastern part of the state, commercial production has not been found but there is no reason to believe that oil pools do not exist. The Pennsylvanian series is exposed and has a thickness of over two thousand feet and production can be anticipated from these rocks where favorable structures exist.

In the Lea County fields, commercial production has been proven to exist in the "Bowers Sand," which is above the "Big Lime."

It is possible that commercial production will be secured from the lower Pennsylvanian and other Palezoic rocks if and when deeper wells are drilled in the areas now producing.

The total income derived by the state from the oil and gas industry, and the distribution of that income to the various institutions, will be discussed in other papers. It is conservatively estimated that the oil industry has invested and indirectly brought to the state a total investment of not less than $500,000,000. There are over 125 operating companies in New Mexico.

On January 1, 1939, there were 2,504 producing oil and gas wells in New Mexico, excluding carbon dioxide wells.

Eighty-three of these wells were in the San Juan Basin, northwestern New Mexico, and 2,421 of the wells were in the Permian Basin, southeastern New Mexico. From January 1 to May 3, 1939, 175 oil wells, 2 hydrocarbon gas wells, 3 carbon dioxide gas wells, and 17 dry holes were completed. One hundred and twelve wells were being drilled May 3, 1939.

The ten refineries and cracking plants in New Mexico have a total daily capacity of 8,215 barrels. The six natural gasoline plants in the state have a combined daily capacity of 235,000 gallons, but it is a significant fact that New Mexico imports approximately 60 per cent of the gasoline consumed within its borders.

The total capacity of the oil lines in New Mexico is approximately 145,000 barrels daily. In 1938, New Mexico produced 35,510,176 barrels of oil from 29 fields, and the state ranked sixth among the oil producing states. The total oil production from New Mexico fields through 1938 is 194,643,870 barrels. Approximately 40 per cent of the producing wells are on state-owned lands.

ACKNOWLEDGMENTS

Considerable data presented herewith were obtained from the late Dean E. Winchester's report, "The Oil and Gas Resources of New Mexico," published in 1933 by the State Bureau of Mines and Mineral Resources, as its Bulletin No. 9, and from various individuals and companies interested in the petroleum development of New Mexico. Criticisms and suggestions were furnished by T. P. Wootton of the well log division, State Bureau of Mines, Socorro.

DISCUSSION

By C. E. NEEDHAM [1]

Mr. Andreas has given us a very clear picture of the history of petroleum development in New Mexico to date. In considering some phases of his paper for discussion, it would seem that the topic of future development in this state would be of much interest.

As Mr. Andreas has pointed out, New Mexico is producing her oil at the rate of about 38,000,000 barrels per year. At the present rate of production it has been estimated that the state has a supply sufficient to last for about twenty years. However, it must be borne in mind that oil pools, after they have reached a certain stage, produce at decreasing rates, so that the life of a pool cannot be calculated by dividing the reserves by the present rate of production. Also we have no assurance that the present rate of production will be the one followed in future years. There may come a time when it will be necessary to increase the rate of production for the state, but such rate should not be greater than is permitted by sound engineering practice. It is imperative, therefore, that new reserves be developed from time to time if the economic status of the oil industry in the state is to be kept sound.

Deposits of petroleum cannot, of course, be discovered except by the drill. But petroleum geologists and geophysicists are able, through scientific methods, to locate structures that are favorable to oil accumulation. Hence, the chances of drilling a dry hole are much reduced if the well is located by accepted scientific procedure.

If the geology of the United States is studied, it is noted that, with very few exceptions, the petroleum deposits are found in basins that are both structural and depositional in character. It is also noted that most of the oil pools are found on the smaller structures within the basins, generally on anticlines, domes, against faults, in lensing sands of various types, or along unconformities.

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[1] President New Mexico School of Mines and director New Mexico Bureau of Mines and Mineral Resources.

It is further observed that virtually without exception the oil originated and occurs in sediments enclosing organic debris that were laid down relatively close to shore in shallow marine waters.

It is obvious, then, that petroleum geology has become highly technical and involves the consideration of many factors before likely oil-bearing structures can be recognized. These many geologic factors must be coördinated in the whole to make up as completely as possible the entire geologic history of a particular area, in other words, the paleogeography of the area. Although many geologic factors must be considered, the two that assume major importance for New Mexico in the writer's opinion are more and better stratigraphy and more and better sedimentology.

Considering the state of New Mexico, it is recognized that a number of basins are present to help make up the geologic structure of the state. To date, only two of these basins have produced oil in commercial quantities. These are the Permian Basin in the southeastern part and the San Juan Basin in the northwestern part of the state.

The Permian Basin is very large and the geology in certain respects is very complicated. Much of the surface of the basin is covered by caliche or drifting sand, which makes the geology difficult or impossible to work out from surface exposures. New favorable structures are still being found in this basin, so it is almost certain that the future will reveal many more. Naturally, in a huge basin of this type, it will take many years to discover the last favorable structure.

Again, the Permian Basin offers good possibilities for future development from deeper drilling. At present, all the oil produced in this basin comes from rocks of Permian age. Within relatively short distances, older rocks belonging to the Pennsylvanian, Mississippian, and Ordovician systems, productive in the Mid-Continent region, underlie the Permian. It is not known what underies the Permian in the deeper parts of the basin, but it is possible that other Paleozoic sediments are present, in which case deeper drilling might develop huge reserves. The writer believes that the Permian Basin offers more in the way of future oil development than any other basin in the state and that this development will come about both through deeper drilling and recognition of new oil traps within the basin.

The San Juan Basin is also large but has never developed such great quantities of oil as the Permian Basin. Development in this basin has been confined largely to structures near the rim of the basin and at shallow depths in the Cretaceous rocks. Just as in the Permian Basin, future exploration should discover new structures and deep productive formations.

The surface over the middle parts of the basin is covered with Tertiary sediments which largely conceal the underlying structures. Formerly, it was somewhat held that when a basin was formed by earth forces that the anticlines and domes would be found mainly near the rim and few oil traps would be formed in the middle of the basin. The recent discovery of tremendous oil deposits in the very heart of the Illinois coal basin proves that this theory is untenable. It seems that under the Tertiary cover of the deeper parts of the San Juan Basin oil traps should be found.

It is mentioned above that most of the oil in the San Juan Basin has been produced from the shallow Cretaceous sands. However, in the Rattlesnake pool, near Shiprock, Pennsylvanian limestones have been proved productive. There can be little question that other reserves in the deep Pennsylvanian formations in many other known structures in this basin are merely waiting to be tapped with the drill.

Although the two basins just discussed appear to hold the greatest promise for future development, there are others that are worthy of prospecting. The Tucumcari Basin has a number of favorable structures but no commercial deposits of petroleum have yet been found. It is interesting to note, however, that carbon dioxide gas in commercial quantities has been developed in the northern part of the Tucumcari Basin.

The Raton Basin, separated on the southeast from the Tucumcari Basin by the Sierra Grande Uplift, appears to be worthy of more prospecting. Great thicknesses of Cretaceous organic shales, presumably good source beds, occur within this basin, and it would seem that favorable traps should be present.

The great Tularosa Basin has received considerable attention from geologists. This basis is bounded on the east by the folded and faulted Sacramento Range and on the west by the San Andres Range, much like the Sacramento Range in character. The Tularosa Basin between is now recognized not as a simple basin but as a great complex structural feature. Gentle folds can be recognized in places, and it is considered that some of these are favorable for prospecting.

The Gallup Basin, west of the Zuni Mountains, offers some possibilities for oil development. It is small, yet it is large enough to hold an oil structure of considerable size.

Many parts of New Mexico must be classed as unfavorable for future development of petroleum deposits. Although it is not wise for geologists to absolutely condemn certain areas, because geologists can and do make wrong interpretations, yet attempting to develop petroleum in some parts of New Mexico is little more than sheer folly. Among such places are to be listed the lofty mountain ranges, the series of highly faulted grabens along the Rio Grande, and the lava plateaus of the western part of the state. Little is known of the subsurface geology in the great desert plains around Deming. Oil seeps are reported from this region, just as has been done from the desert plains around Phoenix, Arizona. Inliers of Paleozoic and Cretaceous sediments are known in many places, and it is the writer's belief that some parts of these desert plains may have possibilities for development of small oil pools.

NEW MEXICO'S ECONOMIC AND FINANCIAL STAKE IN OIL

By HUGH L. SAWYERS[1]

It is indeed a privilege and a pleasure for me to have the opportunity of addressing this conference today. I have a feeling that most of you are not aware of the significance, magnitude, and importance of the oil and gas industry in New Mexico.

As a representative of the industry, I have definitely felt that the people of the state, outside of the oil producing areas, are not fully aware of the economic and financial value of oil and gas in New Mexico. Few people know or realize that the state is in the oil business.

It would be well, at the outset of this discussion, to outline briefly something of the history of our oil development, and survey the state's present status in the national oil picture.

According to early records, oil was known to exist in the extreme northwest corner of New Mexico as far back as 1882. Evidence of petroleum in the southeast corner—Eddy and Lea Counties—was known as early as 1900. Governor M. A. Otero, in his annual report for 1902, calls specific attention to possible discoveries in several counties of New Mexico and had this to say in regard to the southeast corner, "From the Texas boundary to within a few miles of Carlsbad are fine indications of oil."

From 1902 to 1914, several wells were drilled in Eddy County with no great success. However, about this time the "Old Williams" and "Hammond" wells were discovered and proved to be the forerunner of what in later years was to become a great oil pool.

In 1922, after forty years of pioneering and exploitations, oil comes in commercial quantities and New Mexico finds herself in the oil business with the Midwest Refining Company's "Hogback" well in San Juan County.

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[1] Tax agent, New Mexico Oil and Gas Association, Las Cruces.

In 1924, the "Artesia" field in Eddy County was also rated a commercial producer and the first royalty check of $124 was received in the State Land Office from the Flynn, Welsh, Yates Oil Company, which is still operating in this field.

The first commercial well in Lea County was in the Jal area, completed by the Texas Company on November 1, 1927. Two years later, on November 8, 1929, the eyes of the oil world were directed to the sensational Hobbs pool and the great possibilities of Lea County. Oil had definitely come to New Mexico.

Since 1929, discovery of pool after pool has been the reward of the industry and of the state of New Mexico and its institutions, who are the largest owners of the oil producing lands.

In the national picture, New Mexico ranks sixth among the oil producing states—preceded by Texas, California, Oklahoma, Louisiana, and Kansas, and closely followed by Illinois.

The United States produced last year 1,212,907,000 barrels of crude oil, or 61.4 per cent of the world's total, from 371,875 wells.

New Mexico produced 35,770,000 barrels, or about 3 per cent of the nation's total, from 2,321 wells.

We have an area of 78,412,000 acres and about 134,000 proven acres, under which the industry's best engineers estimate 703,252,000 barrels or about 4 per cent of the nation's crude oil reserves, a twenty-year supply, under present proration, if no new pools are discovered.

ECONOMIC STAKE

We are here to consider the oil and gas industry and its economic relationship to the state and to your local community.

Oil contributes so extensively to virtually all phases of New Mexico's economic life that real difficulty is experienced in attempting to trace down all the benefits emanating from it. The search for oil has spread over twelve of the state's thirty-one counties and actual production is found in four—Lea, Eddy, San Juan, and McKinley.

It has been said, and I think correctly so, that more money is being put into the New Mexico petroleum industry than is actually taken out. This is largely due to the fact that the industry is constantly exploring into many sections of our state, reinvesting returns from operations and bringing into the state new capital in order to fully develop our productive possibilities. Encouragement of new capital and the incentive to reinvest returns from invested capital are prime requisites to the success of any state program of industrialization. The prosperity of the state is vitally dependent upon continued orderly, conservative, and sane development and production of our greatest natural resource—petroleum.

The industry is the largest and most important segment of our economy, and its well-being is, consequently, of prime importance to the whole state. The growth of the petroleum industry in New Mexico has been very rapid, evidence of which is found in Lea County. Whole cities have been built as a result of oil; miles of streets and highways, a new railroad, hundreds of new homes and business houses have been constructed; valuations have increased, and schools, unsurpassed in their magnificence, have been built in several oil field towns.

Employment, directly and indirectly, is furnished for thousands. It is emphatically true that the industry has contributed heavily to meeting the cost of state, school, and local governments.

Note these figures taken from official sources: In an analysis of the various sources of income it is interesting to note that the industry, with approximately 10 per cent of the state's property value, contributes 100 per cent of the conservation and production tax, 20 per cent of the franchise tax, 25 per cent of the sales tax, 93 per cent of the severance tax, 40 per cent of the income tax, 81 per cent of State Land

Office revenue, and will pay an estimated 50 per cent of the new use tax.

During the past seven years the amount collected from oil and gas leases and royalties has amounted to $12,232,776.37. In 1938, income accruing to the state and sub-divisions totalled $5,465,000, approximately one-fifth of the state's income. This amount does not include some $4,750,000 received from state and municipal gasoline taxes.

New Mexico oil and gas producers, in the past ten years, have spent an estimated $165,000,000 for salaries, wages, supplies, royalties, etc.

The average well produced under proration will be contributing in taxes and royalties to the state, institutions, and local governments for the next eighteen to twenty years.

A study of recent figures reveals that the constantly increasing tax levies on the industry has definitely lightened the tax burdens of other property owners in the state. In one county, property values have increased manifold; in another the values have been materially increased and in the third oil producing county, values have been kept up and even increased somewhat by reason of oil production in spite of a decrease in value on other forms of property.

The benefits accruing from the oil and gas industry must, therefore, reach down into the most remote and smallest village in the state, however removed from the producing field.

Too often the county or town somewhat removed from the sound of drilling wells or the chug of pumps feels that it has no direct interest in the oil and gas industry in New Mexico and that it does not receive any benefits from it. This is an erroneous impression, for does not the 25 per cent of the industry's share of the sales tax, 93 per cent of the severence tax for the poor, aged, and blind, and the production, income, and other forms of taxation reach every corner of the state?

The state is the largest lease and royalty owner. Last year, income from these two sources alone amounted to

$2,881,130.17. In addition, the industry's royalty payments to land owners have been widely distributed to many individuals.

The industry has made it possible for the state and local governments to carry on services on a higher level in spite of the limitation on property tax rates.

In many oil producing school districts, oil and gas are now paying from 25 per cent to as much as 96 per cent of all direct school levies. Every school and 100,000 school children, in every section of the state, benefit directly from oil and gas revenue.

At the present time very little of our oil is either processed or used locally, but transported through pipelines and tank cars and goes into trade channels into other parts of the country. Petroleum refining, on a much larger scale, may sometime in the future raise the industrial rating of our state.

This paper would not be complete without a few words regarding taxation—a very important item in our economic structure.

It is easy to imagine the benefits that will result to the state in an increasing degree if the industry is not handicapped by unwise legislation and confiscatory taxation, which would destroy the industry's incentive for continued development of New Mexico's greatest natural resource.

The cost of finding and producing oil is one of the main considerations and included in the cost is the item of taxes. A major problem now confronting the industry in New Mexico—besides excessive taxation—is not one of finding oil, but maintaining our market against competition of other oil producing states.

The state does not enjoy a monopoly on petroleum and its products. Operating costs, taxes, and market constitute influences of far-reaching importance in the determination of the state's future oil development. When too great a proportion of returns is taken for taxes, stifled development results. This dangerous relationship already exists with present assessments and levies upon New Mexico's oil and gas production.

Much of the income from oil, accruing to the University, is received from pumping or stripper wells—wells producing from one to ten barrels daily. High taxes imposed upon these wells will contribute greatly toward their early abandonment. Frequently a very slight tax increase will mean the difference between abandonment or operation.

Due to the nature of our business, the tax collector has easy access to the money till and as a result the industry pays its taxes to the last dollar. Tax costs continue to mount. The industry does not complain against the payment of just and reasonable taxes, but does complain, and justly so, at unfair taxes and taxes which amount to confiscation.

In all fairness to an industry which contributes so largely to the welfare and progress of our state, every effort should be made to reduce the tax load of the oil and gas industry and to encourage greater development. Farsighted citizens, interested in developing the natural resources and also the state, must readily realize this.

FINANCIAL STAKE

What the oil and gas industry has meant to New Mexico in a financial way is self-evident. Occurring during the years of the depression, when business stimulation was most acutely needed it has been most valuable to the state and its citizens. Today New Mexico is faring generously at the hands of the industry. In 1924, the state derived practically no income from this source, while in 1938 the annual revenue from oil and gas production approximated $5,450,000.

From a humble start a few years back, Lea, Eddy, and San Juan counties today present an orderly alignment of steel derricks, camps, plants, and refineries from which New Mexico derives the greater part of its income.

The following figures for 1938, setting forth the amounts accruing to the state and sub-divisions, bring home specifically to New Mexicans the importance of oil and gas, for it certainly contributes heavily to meeting the cost of state and local governments. The following state taxes are paid by the industry:

Production tax	2.4%	$ 400,000
Severance tax	2 %	700,000
Sales-School tax	2 %	850,000
Conservation tax	1/8%	42,500
Ad Valorem tax	2.4%	250,000
Franchise tax		33,800
Income tax		150,000
Leases—State		1,180,400
Royalties—State		1,583,950
Leases and Royalties—Federal		275,600
TOTAL		$5,466,250

Note that these figures do not include $4,750,000 received from state and municipal gasoline taxes.

The income from oil and gas for 1938 increased $2,584,650 over 1936, and $289,100 over 1937.

During 1938, approximately 35,770,000 barrels of oil were produced, valued at $28,689,100, on which there was returned to the state from all sources, as outlined above $5,466,250, or $15,000 for each day in the year.

Because of lack of accurate records during the early years of oil and gas development, it is impossible to estimate all receipts from this source. However, we do know from Land Office records that from 1932 to 1938 the commissioner of public lands has collected $12,232,776.37 from oil and gas leases and royalties. A few years back, the principal land office income was from grazing land and the livestock industry. For the past ten years income from this source has greatly diminished, now paying less than 12 per cent of the total, while the petroleum industry accounted for 82 per cent of the total income for 1938 and 78 per cent in 1937. The public schools and state institutions—University, A. & M., and other state schools are the principal beneficiaries.

Total collections from the 2 per cent severance tax, which goes to the poor, aged, and blind, since the enactment of the law, March 1, 1937, to December 31, 1938, a period of twenty-two months, has totalled $1,257,284.54, of which the petroleum industry has contributed $1,172,245.27 or 93.23 per cent, the potash industry contributing $65,143.80 or 5.18 per cent. All other industries, including lumber, copper, silver, gold, and coal contribute less than 2 per cent.

Sales or emergency school tax collections totalled $3,617,697.57 during 1938. This 2 per cent tax, which is used entirely to supplement common school funds, is levied on each barrel of crude oil as it flows from the well. Last year the industry contributed approximately 25 per cent of the above total.

Thirty-seven and one-half per cent of the income from federal leases and royalties are returned to the state in which the income originates. Last year the state's share from this source amounted to some $305,000, of which approximately 90 per cent is derived from oil and gas leases. Under our state laws these funds, less $12,500 for the School of Mines, are credited to the Free Text Book Fund and used to provide free text books in our public schools. Again, the industry is by far the largest contributor.

In 1931, the total taxable value of the state was $331,675,880, including pipe lines valued at $4,515,493, oil and gas production $3,440,230, and railroads $90,530,741. By comparison, in 1938, the state's taxable value was $312,321,060 including pipelines valued at $8,057,495, oil and gas production $16,340,400, and railroads $76,396,212, and an item of $3,505,100 on oil and gas well equipment not appearing in the 1931 assessment.

Lea County continues to lead all counties of the state in valuation. The assessed valuation in 1938 totalled $28,906,737, an increase of 687 per cent in twelve years due solely to the development of oil and gas.

The industry's assessed valuations in Lea County amount to 81.23 per cent of the total; corporations, namely telephone and telegraph companies, banks, railroads, etc., amount to 4.35 per cent; and all other property—livestock, personal, and real estate, 15.42 per cent.

The foregoing facts and figures on the state's income and values as the result of the oil and gas industry causes one to meditate upon the fiscal condition of the state, and its political subdivisions, were it not for the existence of the petroleum industry in New Mexico.

It is extremely fortunate for us that "Oil comes to New Mexico."

DISCUSSIONS

By C. P. MILLER [1]

I appear before you this afternoon to discuss a paper which, through unavoidable circumstances, has not been in my possession for study prior to its rendition.

I feel the subject has been covered adequately by those who have preceded me and, therefore, anything I may say at this time is given more in the nature of an interpretation of several points which I have anticipated rather than an addition to the facts presented.

There is no question in my mind about New Mexico having a stake in oil. It has—and the stake is very large. However, I feel the subject should not be treated so much in terms of barrels of oil but rather in terms of the benefits to the citizens of this state from these barrels of oil.

It may interest you to learn that the development and operation of oil properties in Lea County alone afford employment for approximately nine thousand men at the present time. It may interest you further to realize that the discovery and development of these properties has made possible the building of modern towns and roads; that it has brought to an otherwise isolated portion of New Mexico the modern facilities of transportation, communication, education, and medicine. That it has brought good churches and other community organizations.

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[1] Geologist, Hobbs, N. M.

It is of vital interest to the entire state to know that this industry pays on its gross production a tax of 5.23 per cent; that it pays to the state, in the form of royalty, the equivalent of one barrel out of every eight barrels produced; that it pays to the state annually many thousands of dollars in the form of lease rentals. If you don't think these are vital factors just try taking them away and imagining the results. Many a cattle man and rancher in Lea County has a bank balance today, not necessarily because of his ranch or cattle, but rather because of the lease bonuses and the many rentals which he has received from oil companies.

I used to think, when I was perhaps less well informed than now, that all there was to being an oil operator was to drill a few wells and then just sit back and take life easy. I have since come to the conclusion that I may have overlooked a few facts.

At the time of my less well-informed period I failed to realize that the average cost of producing a barrel of oil in southeastern New Mexico was approximately 25 cents and that the average cost per barrel for prospecting charges might run as high as 20 cents and that I might, therefore, be forced to produce my wells some six or seven years before I could really call my own any of the returns from my investment. It seems I must have been expecting a miracle.

Unfortunately, many people think today, even as I used to. Let me ask a question at this point: If you were planning to drill a well for oil and had managed to gather together some $40,000 with which to drill it, and in the course of drilling said well you encountered some unforeseen obstacle which would run the cost of that well from your estimated $40,000 to $200,000, just where would you figure to come out? This very thing has happened in New Mexico.

It is not my intention to play up the less glamorous side of the oil game because some of you here who are not now in it may have a leaning in that direction, however, in fairness to all, I think it should be said that in order to evaluate "New Mexico's Stake in Oil" consideration should be given both sides.

We who are in the oil business are not in it just for health's sake, although such may be affected advantageously, indirectly. We believe that it is and can be maintained as a profitable business. We believe that in spite of all of our good luck and all of our bad luck we will remain in the oil business and that it is to the advantage of the entire state that we be permitted to so remain.

By VERNON G. SORRELL [1]

In my discussion on this subject, I wish to direct my comments to the position of the oil industry in the general tax picture. As background for my few remarks it would be well to take a look at the broader aspects.

In 1936, the latest year for which the most complete figures are available, the total cost of government in the United States was something over seventeen billions of dollars, of which approximately one-half ($8,666,000,000) were expenditures of the federal government. Twenty years previously, in 1916, the total cost of government was $3,261,000,000; in other words, government cost us more than five times as much in 1936 as in 1916. In 1916, government took 8.4 per cent of the national income and in 1936, 26.1 per cent.[2]

According to compilations made by the Taxpayers Association of New Mexico the cost of government in New Mexico in 1915 was $6,348,832 and in 1936, $26,898,224, an approximate four-fold increase. In 1939, this organization estimates the cost will be $36,333,840, an increase of approximately ten million in three years.[3]

Whether or not these huge expenditures, and tremen-

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[1] Professor of Economics, University of New Mexico.

[2] Figures are those presented by Prof. F. R. Fairchild, Yale University, in a paper presented to the economic advisory council of the Industrial Conference Board, February 23, 1939.

[3] The figures for certain years, as compiled by the Taxpayers Association of New Mexico, are as follows:

1915	$ 6,348,832	1934	$23,361,986	1938	$35,772,320
1919	10,555,697	1936	26,898,224	Est. 1939	36,333,840
1920	13,009,469	1937	29,448,752		

dous increases, have been justified I know of no scientific way of telling. There is a principle of public finance that says that if money spent by government is more conducive to general welfare than if spent by private individuals then taxation is justified. However, this principle is most difficult to apply in any scientific manner; and, at any rate, whether government is costing too much or too little is too big a subject to enter into at this time.

But there are certain problems connected with the raising and spending of these colossal sums that should be brought out. Outstanding among these problems at present is the grave financial situation facing the federal government. With a continuous unbalanced budget for eight years, and with no prospects of a balance for several more years at least; and with a national debt estimated to reach forty-four billion in 1940; the problem presented here is not only that of servicing this debt along with the other expenditures, but also (and this is the more grave problem) that of avoiding, if we can, a runaway rise in prices.

While not in the least minimizing the problems of raising and spending public moneys in New Mexico, or any state for that matter, the major issue now is with the federal finances.

And now coming particularly to petroleum taxes. The fourteen-and-one-half-billion-dollar (total investments estimated by Pogue) petroleum industry paid in taxes in 1938 $1,277,680,972. Considerable part of this amount, of course we cannot say how much, was shifted to the oil and gasoline users in higher prices. With a seventeen billion dollar government cost figure in 1936, petroleum taxes account for approximately one-thirteenth of all governmental revenues. In 1938, according to figures published by the Tax Policy League, gasoline taxes ranked third in yield of all taxes, property taxes being first and income taxes second.

Mr. Sawyers has told you how the state of New Mexico raises revenues from the oil business amounting to a total of $10,216,250 in 1938, or over one-fourth of the total cost of government in the state for that year. He lists eight different taxes: production, severance, sales, conservation, ad valorem or property, franchise, income, and gasoline, in addition to rents and royalties, which are properly not taxes. The question naturally arises, "Why have so many different types and forms of taxes on one industry? Could not taxation in the oil industry be simplified?

Is it impossible or impracticable to accept certain principles and then devise a system of taxation in accordance with these principles?

Several years ago a committee of the National Tax Association drew up what was called a model plan of state and local taxation, recommending three major objects upon which taxes should be levied; first, a tax on persons in respect to their net incomes; second, a tax on property as measured by the value thereof; third, a business tax levied at a flat rate on net income. I think tax economists are in quite general agreement on these principles, but no state, so far as I know, has even approached consistency in their application.

This committee recognized that in certain more or less specialized fields, as in natural resources industries, it might be justifiable to depart from the above stated principles. They made mention of the severance tax principle, but suggested that this field be studied by a special committee. I know of no committee, or group, that has studied objectively and impartially the taxation of the oil industry with a view to recommending proper and sound methods in this field. I, for one, would like to see a special committee of the National Tax Association undertake this task; or if that was impractical, or impossible, then a special group of students of taxation from the oil producing states might be constituted in some manner to make the study and to offer recommendations.

Another problem in oil taxation is the trend toward diversion of state gasoline taxes from highway construction and maintenance to other purposes. In 1927, something over $5,000,000 was thus diverted, but by 1937 this had rapidly increased to $131,000,000 or 17 per cent of the total amount collected. Forty-eight millions of this $131,000,000 went into general funds, $32,000,000 for relief, $31,000,000 for education and public schools, and the balance into such things as administrative expenses, rural credit bonds, harbors and docks, state police and highway patrols, aviation, commerce and navigation, general fund bonds, construction bonds, state departments, irrigation, and beach protection. (From Finla G. Crawford, Motor Fuel Taxation in the United States.)

The question of whether to divert these taxes from their original purpose seems to have become definitely an issue in many states, and with the introduction of the federal 1 cent gallonage tax the question has taken on national importance. New Mexico's state tax has not been diverted, but this is not true of the municipal taxes in the state.

The arguments for not diverting usually run somewhat as follows: the users of the highways are primarily motorists and the tax rightfully should be borne by this class. Thus the tax is a benefits-received tax. The construction and maintenance of a highway system is an essential function of government and nothing is more fair than that the users bear this burden. Other functions should be supported by other taxes, the argument runs, and if more gasoline taxes are collected than sufficient for an adequate highway system then the rates should be lowered.

The arguments for diversion may be stated somewhat as follows: As a general principle taxes should not be earmarked, as expenditure control can more properly be handled through budgetary procedure. Further, gasoline is a commodity used by almost all who benefit from many functions of government and to tax such a commodity is a good method of spreading the burden over many people.

In conclusion, I would like to summarize what I think we may expect in the future in the matter of taxation. It seems quite likely that total taxes will increase in the future, but at a slower rate than in the some half dozen years just past. At present, there seems to be a definite trend among the states for economy, and there has been considerable talk in our national Congress along the same line. A greater portion of our taxes will go for such things as old age pensions, public health, and other public welfare activities. It is likely that a smaller proportion will go for education, especially public schools, in view of the fact of the decline of one and one-half million in the school age population in the last ten years. It seems likely that highways will take proportionately less in the future than in the past.

Of course all our predictions and outlook for the future may well be knocked into a cocked hat if we should have inflation. And if we should have war then as to just how bad our financial situation could become, one person's guess is as good as another.

By DUDLEY CORNELL[1]

The topic under discussion is "New Mexico's Financial and Economic Stake in Oil." We have all profited, I am sure, from the very able discussions by Mr. Sawyer and Dr. Sorrell. Most of the remarks and, in fact, most of the topics for discussion upon the program relate to the producing side of the oil industry. This, of course, is the most interesting aspect of the industry, and there is always something fascinating about the search for and the production of liquid gold from the hidden recessees of the earth. The marketing of petroleum products, on the other hand, has the same appeal as the corner fruit stand or grocery store, but I want to emphasize the fact that New Mexico has a large and important stake in the marketing side of the oil business.

There are 2,426 outstanding retail licenses for marketing gasoline and each one of these licenses represents from one to eight gasoline pumps. The filling station has been extended into every county and every mountain community. It is a safe guess to state that every retail license represents two men who are making their living out of the oil industry.

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[1] Petroleum Industries Commission, Albuquerque.

There are 277 distributors' licenses outstanding as of May 1, and 165 wholesalers' licenses. The distinction between a licensed distributor and licensed wholesaler is that the distributor is responsible for the gasoline tax, whereas the wholesaler buys his gasoline with the tax paid.

Seven hundred gasoline tank trucks and gasoline transports have been guaged by the Bureau of Revenue official testing stations. Assuming one employee or worker for each of these licenses and one for each truck, we have 1,142 more making a living out of the marketing of petroleum products, or a total of 5,994 citizens of the state of New Mexico directly obtaining their living from this business. Add to this the wives, children, relatives, and dependents of this regiment of oil men, and you have a sizeable portion of our population. This does not take into consideration the division offices of major companies, salesmen, supervisors, and district representatives that will add at least another 100 to the list.

The state collected from the 5 cent gasoline tax the sum of $4,485,031.46 in 1938 and refunded $419,503.50 to farmers and others making a net collection of $4,065,527.96. Each month the state collects over $300,000 from this source, and this sum is paid by fifty-seven taxpayers. The chief burden of bookkeeping and collecting the tax is assumed by the companies, and in every oil company office 30 per cent to 40 per cent of clerical and administrative time and expense is taken up with work devoted to the keeping of records and making of reports simply for the paying of taxes.

There are twenty-two incorporated municipalities in New Mexico that are collecting a municipal gasoline tax of one-half cent to one cent. The total of these collections for 1938 was $172,512.60.

The state gasoline tax is used to finance our state highway system and to retire our highway debenture bonds, of which eighteen million were outstanding January 1 and six million more authorized by the last Legislature. The city taxes are used for a variety of municipal purposes; salaries of policemen and other city employees, municipal swimming pools, municipal bands, fire equipment, and any number of purposes.

There are no figures available regarding the investment in and present value of the real estate and equipment used in the marketing of petroleum products in New Mexico, and no way of arriving accurately at the income to the state from taxes upon them. For example, many filling stations are owned by individuals, and a search of county tax rolls will not show that it is a filling station location at all. Only a few company-owned properties are listed as filling stations on the tax rolls. To take the 2,426 retail licenses and try to check the tax rolls would be a fruitless task because they are issued to the operator, who is, in most cases, not the owner of the premises.

So, at the risk of being accused of indulging, perhaps, in a fanciful flight of imagination, I am going to try to estimate some general figures by taking the best and most conservative averages possible.

I have consulted with a number of experienced marketers, and we have accepted the following averages. The first question is, what is the value of the real estate and equipment of the 2,426 retail establishments represented by the 2,426 licenses outstanding? You must realize that many of these represent investments of from $15,000 to $40,000; whereas, many are a single pump and tank, valued at not over $200 to $300. The average we have taken is $2,500. This means a retail investment of $6,065,000. The bulk plants likewise vary in cost and value, but the same figure of $2,500 seems to be very conservative for these. This makes $1,105,000 for the wholesaler and distributor. The 700 tank trucks can be valued at $1,500 each, which makes $1,050,000. This is a total of $8,220,000, which is a very conservative figure, in my opinion.

The retailers pay $500 for the retail licenses and the distributors $25 each for theirs. In the last fiscal year the Bureau of Revenue received $21,172.76 from these license fees. In addition, they pay license and occupation taxes in every city which does not collect a city gas tax. They pay state and county taxes on the filling station and bulk plant locations and sales taxes and license fees on their trucks.

To summarize the stake of New Mexico in the marketing of petroleum products: We collect $4,500,000 in state gasoline taxes and $172,512.60 in municipal gasoline taxes; almost six thousand persons are employed in the industry in the state; the industry has a total investment of $8,000,000. These employees and this investment are scattered throughout every corner of the state, and their influence is felt in every community in the state. New Mexico has a large stake in oil when the marketing facilities are added to the production, pipeline, and refining divisions.

THE OIL INDUSTRY AND EDUCATION

By GEORGE I. SANCHEZ [1]

As a preface, or theme song, to my remarks I call to mind some of the arguments that were raised several years ago about assigning revenues derived from the liquor business to the public schools. In response to these arguments, my good friend, Dr. Vernon O. Tolle, used to state: "You may say that it is tainted money but you can't say 'taint money."

It was my original plan to present, at this time, an analysis of the revenues accruing to public educational institutions from the oil industry. After some deliberation I have chosen not to present a research paper on school finance at this meeting. I have been impelled to this choice by the belief that, in the past, we, as educators and as taxpayers, have been thinking at cross-purposes when we have dealt with the problems of school finance and administration. Under such conditions statistics are meaningless.

It has been evident in past discussions over financial matters that we lack a common ground of understanding.

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[1] Associate Professor of Education, University of New Mexico, Albuquerque.

We, apparently, are not agreed as to the principles underlying the relationship that exists between public education and public finances. It is my feeling that there are those in New Mexico who hold to the view that the industry or organization that meets its legal public obligations through the payment of taxes has special rights and privileges, over and above those residing normally in every citizen, in determining what is to be done with those taxes and how the public function which they support is to be discharged.

For the purpose of raising this issue, I will take the point of view that we are not concerned with how much or how little of the school revenues are produced by the oil industry. Similarly, we are not concerned as to whether these revenues are raised in Lea County or in Torrance County, through direct or indirect taxation. We are concerned simply with the fact that there are problems in educational administration which arise because we have an oil industry which produces public revenues—whether or not those revenues find their way directly to school funds. We are concerned with the oil industry solely as with any other influential organization that can aid in making the state a better place in which to live. The same can be said of the cattle industry, of real estate, of motor vehicles, and of other private assets that constitute the taxable wealth of the state of New Mexico.

There is a definite fallacious tendency to consider certain locally produced revenues as revenues to which the producing locality has a special claim. This, coupled with the emphasis placed upon the amount of revenues produced and the erroneously implied special obligation of the spending agency to the producing organization, has unduly complicated the task of school finance and administration.

There are problems in school administration that have a more important bearing upon taxation than the considerations involved in the above allusions to special treatment and privileges. Sound tax systems and proper public administration are not incompatible with the interests of any industry. Due attention to the basic problems of educational administration would result in far more important economies to the taxpaying interests of this state and to the public generally than present penny wise and pound foolish tactics on the part of both spending and producing agencies.

It sounds almost chauvinistic and utopian to suggest that educators, the spenders in this case, and the oil operators, the producers, join forces in seeking reforms in the educational and tax systems of this state. But it is self-evident that it is far more important, speaking from a financial as well as an educational point of view, that we improve our system of county school administration than that we quibble over whether or not this or that petty sum is to go into a school budget. It is of greater import to educators and to taxpayers that we have a competent educational budget auditor than that we increase or reduce the direct charge fund of some humble rural school district. It is of more value, from both a selfish and from a public viewpoint, that we work out a sound system of assessment and of tax collection than that we appear before legislative bodies as vested interests seeking special privileges.

We have spent more efforts in these puerile ways than would be required to achieve a greatly improved program of school administration—a program that would rebound to the financial gain of the taxpayers and to the educational welfare of the state. To date, we have engaged in too many short-sighted practices on the incorrect assumption that the interests of the taxpayers and those of the educators were incompatible. Mayhap that is why today we labor under a system of school administration that is costly and inefficient, that expends some revenues unnecessarily and others to no good end—that, in other words, does not give us our money's worth. Yet, instead of getting at the root of the problem, each of us in our own way has sought, by patchwork procedures, to remedy a minor defect here, an omission there, little realizing that these weaknesses are but symptomatic of the fundamental weakness of the entire structure.

I should like, at some time, to go into a discussion of the problems which bear out the views expressed above. For the present, I will limit myself to citing one problem for which no sound solution has as yet been found. I refer to instability of the population under certain conditions and to the school problems resulting therefrom. In oil towns, in mining towns, and in certain agricultural sections the population fluctuates with the ups and downs of markets and like influences in an unusual degree. The satisfactory operation of a school program under such circumstances is exceedingly difficult.

At the initial stage of a large increase in population, capital outlay funds are not available and the problem of housing the school children is indeed a serious one. As the particular industry which has brought on the influx of population progresses, real values are enhanced and the community pledges those values for school building purposes through bond issues. It is obvious that both at the initial stage, when real values are not sufficient to meet school building needs, and at the later stage, when those values are high, there is need for very careful planning and for administrative devices which meet the educational needs of the children and which protect the economic interests of the community.

Does the nature of the industry warrant an expensive "rock of ages" type of building program? Do we construct fifty-year buildings for communities that will be "ghost towns" in ten years? Similarly, are we building massive stone structures in regions where climatic conditions and geography call for a lighter type of construction which would prove just as satisfactory and considerably less expensive? Couldn't we, through the use of state emergency loan funds, meet school building needs at the beginning of a "boom" and reimburse the state when local values are higher?

These and many other similar questions are of significance to both the educator and the taxpayer. However, they cannot be solved on the spur of the moment by the local schoolman or by the tax experts of the industry. Intensive study of population trends, critical evaluation of architectural plans, legislative enactments, and administrative regulations—the solution lies in long-time planning by a competent school buildings and equipment division of a professional state department of education. The cost of such an agency is negligible in the light of the expensive errors that are committed in this field.

The problems suggested with reference to population and school buildings have their counterparts in other phases of school administration and finance. Teachers' tenure, salary schedules, supervision, transportation, vocational education, and school curricula, and similar fields are areas within which sound planning will result in major economies and improved education. Again, the problems which are continuously arising in these fields cannot be solved to the satisfaction of the industry, and certainly not to the satisfaction of sound-thinking educators, by patchwork, hit-and-miss, quack remedies which occur to us on the spur of the moment at a school budget hearing or at a legislative committee meeting.

It behooves industry and the educational profession to seek more lasting remedies to these problems. A sound system of state and county school administration is not only good for education but it is good for industry. Competence and efficiency in school administration and finance is not only good education but it is also good business.

DISCUSSION

By W. G. DONLEY

Since I have been unable to secure Mr. Sanchez's paper, I have taken the liberty to discuss some of the uncommon problems of schools located in oil producing communities.

It seems to me that it is a sound policy that the first

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1. Superintendent of Schools, Hobbs, N. M.

claim on taxes on any wealth producing industry should be to solve the special social problems that the industry creates, and with this in view, I will enumerate some of the problems of the schools located in the oil fields that come under this classification.

The nature of the industry makes it necessary that a great number of the men must move from place to place every thirty or sixty days, as the development changes. Only the smallest and most temporary houses are available for these workers. Such structures are conducive to family strife and the children are forced out and away from parental influence by the very nature of the size of the home and the proximity to others.

From a partial survey of Hobbs, I estimate that 900 of the 2,700 children enrolled have home conditions as stated above. While the housing conditions cannot be changed, it does seem that special recreational facilities throughout the year are as essential as the regular school program and should receive some budgetary consideration if our juvenile delinquency score is to be brought down from its present high place.

An examination of the admission and withdrawal of students shows that six hundred were admitted this year after the first six weeks had passed, and three hundred withdrew to go elsewhere during the year. Every Monday morning it is necessary to give tests to a large group seeking admission. It is definitely evident that our clerical needs are double those of any stable school community of similar size, if we follow the administrative proceedure employed in comparable systems.

Since the oil industry makes the same demands on the families that serve it, regardless of the state in which located, the children have a definite handicap from the constant change from school to school. Last year, one of our first grade students had been enrolled in eight schools that year, and one eighth grade student had been enrolled in forty-eight different schools during his eight years in grammar school. Of course, these are extremes, but they show definitely that ample funds should be provided to limit the teaching load of these children to a point that the handicap of constant change may be overcome by opportunities of more individual attention.

Just as the oil industry found it absolutely necessary to pay more than average wages to its common laborers as well as its technical men, so it is necessary to pay better than average wages to the teachers employed in such communities if acceptable service is to be secured. No living quarters are available in private homes, so one must live in a hotel at a cost of $50 a month, or must buy property. Experienced and capable teachers cannot be secured or retained under a salary schedule that obtains in the more settled communities.

The extensive distribution of student population in the county where so much heavy traffic is constant, makes transportation a necessity as a safety measure besides considering distance. This item of expense in the school budget amounts to 20 per cent in our county, totaling $65,000, yet in the new equalization bill, no specific mention of such school service is made. The duties of levying and distributing funds that should supply these services have been assumed by the state. Conferences on the new equalization law now in effect reveal that many persons interested in a share of the funds were loath to admit the justice of the premise that the first claim on taxes against industry can justly be made to serve the children of the men who create the wealth, and I, therefore, solicit your interest in the problem. I believe it is just as important for the officials of the oil industry to become interested in the final distribution of the taxes paid by them, as it is to be interested in the amount paid. Your obligations to your employees cannot end until you have seen that the just share of the taxes you pay to support social agencies have been allocated to the communities for the welfare of the children of your men who have created the wealth that make such services possible.

THE EVOLUTION OF PRORATION

By ERNEST O. THOMPSON[1]

Very fast have we progressed in this effort to prevent waste in the production of oil and gas. The whole theory is relatively new. Instead of our finding fault with our efforts, it strikes me that we should rather take encouragement with the ground we have gained along this road called proration. Let us briefly review the trip we have thus far made. First of all, we should remember that we started out with no road map or compass. The road was not marked—not a sign pointing anywhere or telling how far it was to stability.

The trip we have made on this proration and conservation road is best compared with a trans-continental automobile trip in the year 1900. We had only the desire to get somewhere. The difference was that nobody was really trying to keep the begoggled and linen duster-clad motorist from getting along on his twenty-mile-an-hour journey when the going was really good. Everybody really wanted to help. But with our proration and conservation car of progress plenty of well-intentioned sound thinkers of the older school of individualism were putting big tacks all along the road. They were not fooling. They meant business. They wanted to blow the whole thing sky-western-crooked.

How pleasant it is to me now to see many of these honest well-meaning former opponents of proration giving helpful counsel and advice for the application of sound engineering principles to the production of their own oil and gas properties. That exemplifies the complete evolution of proration.

First, Thou shall not pass—you can't do this to me. Then acquiescence, then enthusiastic coöperation. It is all a matter of understanding through experience. That which was at first looked upon as ravishment is now embraced as a great advantage to everyone.

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[1] Chairman, Interstate Oil Compact Commission; member, Railroad Commission of Texas.

We should see what is the economic trend of oil production. You are all aware that the per-well revenues are steadily being reduced and that if this trend continues there will come a time when it will no longer pay to drill new wells. The purpose of this talk is to emphasize that we are now at that point. I have here a table giving the figures for the state of Texas for the years 1937 and 1938, and have estimated 1939.

	Total Revenue	Total Barrels	Number of Wells	Per Well Allowable	Price	Per Well Revenue
1937	$594,500,000	500,318,000	77,360	19.4	$1.16	$7,685
1938	514,800,000	468,000,000	85,387	15.0	1.10	6,029
1939	465,600,000	480,000,000	91,400	14.4	.97	5,094

This is a picture of a steady shrinkage in the total revenues of the oil producers of Texas and a still more rapid decline in the per-well revenue.

The average per-well cost, including lease equipment, is around $25,000. From the $5,094 must be deducted the one-eighth royalty, together with all operating costs, including taxes. If one should subtract a 5 per cent interest charge, the balance, if continued, will pay the well out in between ten and fifteen years. However, the increase in wells in 1940 and 1941 will almost certainly exceed the growth of any market that we can now expect, and one must either assume an increase in price or accept the fact that the per-well revenue will drop again in 1940 and still further in 1941. A very slender margin is left in 1939 for capital return. By 1941, this may very easily have disappeared.

I heard a man testify under oath that the well which he was going to drill would, under the present rates of prorated production, require twelve years to pay out. He swore that he knew that it would take him twelve years to get his investment back with oil at the present price. I had him repeat his testimony and asked the Press represented at the hearing to take notice. I assumed he was not awake to the almost inevitable decline in future revenues. Had he been so he would have been an optimist indeed to have drilled the well.

What I am saying is—bluntly—that the oil business is putting too much money into the ground. An important cause for this is the very large amount of credit available to the producer. Production loans are correct if they represent the use of capital in a safe field from which the money will be returned with reasonable interest. Capital has never been so abundant, and has never been more hard put to find sound and attractive loans.

The oil business, however, has gone through a peculiar cycle. I can well remember when banks looked with suspicion on loans for the purpose of drilling oil wells. Prior to 1930, the oil business was regarded generally as being no place for careful money. During that period the profits were large and those profits reinvested took care of much of the capital requirements of the industry.

Beginning about 1930 the banks began to increase their oil loans. As production, through proration, became more stable the volume of such loans increased. Then came the depression, and good production loans, reducing each month, proved to be the best paper in the banks. This history has built up what is now almost a tradition: that oil paper is safe. The trouble with a tradition is that it continues long after the fact basis that created it has disappeared. Financial circles, during the last decade, looked upon oil as dangerous after it had become safe, and these same circles now look upon it as safe when it may be dangerous.

It has been urged that the reserves will, in time, become depleted, and that oil will increase in price. A few short years ago—in 1925—there was a great hue and cry over the land that we were about to run out of petroleum. At that time it was estimated that our reserves were in the neighborhood of five billion barrels. People said we were going to play out of oil. Scarcity was impending. Let's see what happened.

Since that date we have consumed eleven and one-half billion barrels of oil. Today we have approximately seventeen and one-half billion barrels of oil in reserve in the ground; and over five hundred million barrels of all oils in storage above ground. Truly, we have not run out of petroleum. We are able today to obtain almost twice as many gallons of gasoline out of a barrel as we did in 1925.

Incidentally, the consumer paid 29 cents a gallon for gasoline in 1920, no tax. Today he gets a far superior gasoline at 14½ cents a gallon, excluding tax.

There has been, perhaps, a 50 per cent increase in consumption. This balances out to where we were in that year. This, of course, is a very general statement, but it does forever bar from the picture those who would cry out we are about to exhaust our petroleum supply. I do not expect to see an exhaustion of petroleum. Long before our petroleum is exhausted there will be an ample and adequate substitute economically produced.

The table on page 51 will show how strictly we have prorated in Texas. It also refutes the exhaustion of petroleum soon.

Here is an example of the progress we have made in the recent days in Texas as a result of the realization on the part of the industry that something had to be done to keep from drilling themselves broke with no outlet for the oil.

RAILROAD COMMISSION OF TEXAS
OIL AND GAS DIVISION

OIL AND GAS DOCKET NO. 128.

In re: Conservation and prevention of waste of crude petroleum and natural gas in the North Houston Field, Harris County, Texas.

Austin, Texas, April 7, 1939

AN EMERGENCY ORDER ADOPTING RULES AND REGULATIONS FOR THE NORTH HOUSTON FIELD, HARRIS COUNTY, TEXAS

WHEREAS, The Railroad Commission of Texas on April 3, 1939, held a hearing on the North Houston Field in its Hearing Room in

Pool	Spacing	Current* Date	Pressure	% Pressure Change Per Month	Age (Years)	Years Supply†
		Gulf Coast				
Anahuac	20	6-15-38	3181	.04	4.0	96
Conroe	20	10- 1-38	2066	.07	6.5	59
Raccoon Bend Cockfield	20	1-20-39	1711	.10	4.8	56
Sugarland	20	5-25-38	1378	.05	11.0	50
Thompsons	20	7-13-38	2337	.04	7.4	48
Tomball	20	10-15-38	2284	–.13	5.7	21
Average				.03		
Amelia	10	9- 1-38	3023	–.10	3.0	15
Hastings	10	9-15-38	2705	–.05	4.0	53
Average				–.08		
		Southwest				
Flour Buff	20	8-15-38	2917	.02	2.5	17
Greta	20	7-18-38	1848	.02	5.7	11
Heyser (5400′)	20	10- 1-38	2394	.07	2.8	11
Hilbig	20	8-25-38	1007	.08	6.0	15
Taft (4000′)	20	11-16-38	1752	.09	3.0	21
Tom O'Connor	20	5-10-38	2626	—	4.6	75
McIlroy Field						66
		West Texas				
Means	40	10-28-38	1607	–.12	4.5	47
Yates	30	7- 1-38	532	–.10	10.3	37
Penwell	29	10- 1-38	827	–.47	9.5	15
Goldsmith	20	12- 1-38	1431	.00	3.5	39
Sand Hills Permian	20	11- 1-38	1809	–.14	8.0	57
Average				–.17		
Henderson	10	1- 1-39	1285	–.09	3.0	22
Kermit	10	10- 1-38	837	–.87	10.3	19
Average				–.46		
		East Texas				
East Texas Field	5	2- 1-39		–.11	8.0	18
Average for 20-acre spacing and above				–.011		
Average for spacing below 20 acres				–.246		

*Latest survey.

†Based upon present net allowable.

the Capitol Building, in Austin, Texas, and heard evidence in regard to the promulgation of various rules for the prevention of waste, and

WHEREAS, The transcript of the proceedings of this hearing is in preparation and will be available for study within a few days, and

WHEREAS, Notice has come to the attention of the Commission that pending the completion of the transcript of the proceedings, the following rules for the North Houston Field in Harris County, Texas, should be adopted:

IT IS THEREFORE ORDERED by the Railroad Commission of Texas that the following rules and regulations be and the same are hereby adopted, effective this date, governing the development of and production from the Murphy Sand in the North Houston Field, Harris County, Texas:

RULE 1. Said field shall be divided into tracts of approximately twenty (20) acres each and as the limits of said field may be further extended additional twenty (20) acre tracts may be added by the Commission. Each such producing tract shall be a proration unit; each producing tract containing less than twenty (20) acres shall be a fractional proration unit. A tolerance of ten (10) acres on producing tracts of more than twenty (20) acres shall be allowed when the size and shape of the tract warrants and after the tract has been drilled to its final density. For proration purposes the amount of acreage assigned to each well shall be the acreage contained in each proration unit, whether fractional or not. In all instances, each well shall be located as nearly as practicable in the center of each proration unit.

No well for oil or gas shall hereafter be drilled nearer than nine hundred thirty-three (933) feet to any other completed or drilling well on the same or adjoining tract or farm or nearer than four hundred sixty-six (466) feet to any property line, lease line, or subdivision line; PROVIDED, That where a tract contains as much as twenty (20) acres but is so irregular as to shape that a well cannot be spaced thereon in accordance with the pattern hereinabove mentioned, the Commission will grant exceptions to permit drilling within shorter distances whenever it shall determine that such exceptions are necessary either to prevent waste or to prevent the confiscation of property. When exceptions to such rule are desired, application therefor shall be filed with the Commission fully stating the facts, which application shall be accompanied by a plat drawn to the scale of one inch equalling four hundred (400) feet, accurately showing to scale the property on which permit is sought to drill a well under the exception to this rule, and accurately showing to scale all other completed, drilling and permitted wells on said property, and accurately showing to scale all adjacent surrounding properties and wells. Such application shall be verified by some person acquainted with the facts, stating that all facts therein stated are within the knowledge of the affiant true and that the accompanying plat is accurately drawn to scale and correctly reflects all pertinent and required data. Such exceptions shall be granted only after at least ten (10) days' notice to all adjacent lessees affected thereby has been given, and after public hearing at which all interested parties may appear and be heard, and after the Commission has determined that an exception to such rule is necessary either to prevent waste or to protect the property belonging to applicant from confiscation. All pending applications shall be amended to conform to this rule before being acted upon.

PROVIDED, That in case all adjacent leaseowners waive objection to said location, the Commission may proceed forthwith to hear said application and enter such order as the evidence may justify.

As to all tracts containing less than twenty (20) acres, the Commission, in order to prevent waste or to prevent the confiscation of property will grant exceptions to permit drilling on such tracts upon application therefor as hereinabove provided; PROVIDED, However, the Commission will not grant an application to drill on a tract or tracts containing less than twenty (20) acres until the applicant shall have first made a bona fide effort to pool such tract or tracts with a contiguous tract or tracts, or parts thereof, so as to establish, at least, a twenty (20) acre drilling unit. In all such cases applicant shall offer evidence at the hearing on his application concerning his efforts to enter into a pooling agreement.

RULE 2. The casing program of all wells hereafter drilled in said field shall include at least two (2) strings of pipe set in accordance with the following program:

(a) New or reconditioned pipe with a mill test to twelve hundred (1,200) pounds per square inch shall be set and cemented at a point not higher than fifteen hundred (1,500) feet below the surface. Sufficient cement shall be used to fill the calculated annular space back of the pipe to the surface of the ground. Cementing shall be by the pump and plug method. Cement shall be allowed to stand a minimum of twenty-four (24) hours under pressure and a total of forty-eight (48) hours before drilling plug or initiating test.

Surface casing shall be tested by pump pressure in the following manner:

The mud-laden fluid in the hole shall be replaced by clear water and pump pressure of at least one thousand (1,000) pounds per square inch applied. If at the end of thirty (30) minutes pressure shows a drop of one hundred fifty (150) pounds or more, the casing shall be condemned. After the corrective operation the casing shall again be tested in the same manner.

(b) The producing or oil string shall be new or reconditioned seamless casing that has been tested to two thousand (2,000) pounds per square inch, and shall be set so as to shut off all gas producing horizons lying immediately above the top of the oil producing horizon and cemented with not less than three hundred (300) sacks of cement. Cement shall be allowed to stand a minimum of twenty-four (24) hours under pressure and a total of forty-eight (48) hours before drilling plug or initiating test.

Casing shall be tested by pump pressure in the following manner:

The mud-laden fluid in the hole shall be replaced by clear water and pump pressure of at least one thousand (1,000) pounds per square inch applied. If, at the end of thirty (30) minutes pressure shows a drop of one hundred fifty (150) pounds or more, the casing shall be condemned. After the corrective operation the casing shall again be tested in the same manner.

RULE 3. A blow-out preventer, control head, and other connections for keeping the well under control at all times shall be installed as soon as surface casing is set. The blowout preventer on the surface strings of pipe shall be of dual control or such type of construction and operation as to satisfy any test which may be required by the Commission. Blow-out preventer shall be tested at least once every eight (8) hours; all control equipment shall be in good working order and condition at all times.

IT IS FURTHER ORDERED That this Cause be held open on the Docket for such other and further orders as may be necessary.

RAILROAD COMMISSION OF TEXAS
LON A. SMITH, *Chairman*
ERNEST O. THOMPSON
JERRY SADLER, *Commissioners*

ATTEST:
C. F. PETET, *Secretary*

STATE OF TEXAS
COUNTY OF TRAVIS

I, C. F. Petet, Secretary of the Railroad Commission of Texas, do hereby certify that the foregoing is a true and correct copy of AN EMERGENCY ORDER, issued April 7, 1939, by the Railroad Commission of Texas ADOPTING RULES AND REGULATIONS FOR THE NORTH HOUSTON FIELD, HARRIS COUNTY, TEXAS, the original of which is now on file in the office of the Railroad Commission of Texas, Austin, Texas.

Given under my hand and the seal of the Railroad Commission of Texas, this the 7th day of April, 1939.

C. F. PETET

C. F. PETET, *Secretary*
Railroad Commission of Texas

(Seal)

Experience and experiment are about the only things on which we can confidently rely.

Trial and error is the method by which we have progressed in the problem of proration and oil and gas conservation. Proration of oil is looked upon by most operators as being proper and just when we are prorating the other fellow.

The fat is in the fire after our money is already in the ground. Unless we very quickly and intelligently adjust our spending in unnecessary and needless wells spaced too closely together, we will never get out of the ground what we've put into these holes. The oil industry is going into the next depression with a lag in oil's own economics and oil will thus catch all the evils of normal depressions plus the additional hell that comes from over-investment.

What happens today is not of great interest to me because there is nothing we can do about it. But what is to happen six months from now is of interest. You can do something about that. Whether you like it or not, any calculations on oil in 1939 must make room for two hundred thousand barrels per day of Illinois oil. I am told that there are more Texas and Oklahoma auto licenses in the Illinois fields than there are Illinois license plates. We must be patient with new oil states about passing oil conservation laws. For a while, everyone was calling Arkansas the threat, but now they have one of the best oil statutes of any state and it is being ably administered. Either wisdom or nature will, in the end, prevail in the Illinois fields. By this, I mean that the Legislature of Illinois will in its wisdom either pass a law or not. If they pass a conservation law, they will bring their fields under proper control and restraint so then there will be no need to worry about it. If they do not pass a law, then nature will take care of the situation by blowing its head off in a very short time.

Dr. Bell, state geologist of Illinois, testified at our last Interstate Oil Compact meeting at Austin, Texas, March 15, that, in his opinion, the Illinois fields would reach their peak this 1939 fall and that the peak would be about two hundred thousand barrels of oil per day. The wells in Illinois drop off rapidly. The pressures are very shortly dissipated with the resultant loss in ultimate recovery of oil. I am hopeful that they will see the light and put a waste prevention law on their books at once. But, in order to be safe, it is best to mark up two hundred thousand barrels a day for Illinois' place in the market demand picture.

Our real oil problem will probably come in all its fury in 1940 unless we very promptly make some changes in our present plan of drilling wells so close together. Why do I say the trouble is not to come until next year? We are still enjoying the great increase in demand caused by a 27 per cent boost in exports over 1936.

At the November annual meeting of the A. P. I. in Dallas, Texas, when the Cole sub-committee was also sitting there, a resolution came forth pursuant to the request of the congressional committee that the directors of the A. P. I. make appropriate recommendations.

Here is what the committee recommended, in part:

1. That Congress give its consent to the formulation by the principal oil producing states of an agreement or interstate compact for conserving their petroleum resources.

2. That the principal oil-producing states promptly formulate a compact for this purpose.

3. That the compact should provide for federal coöperation with the states in the investigation and determination of the reasonable consumptive demand for current petroleum production after taking into account importations, exports, and withdrawals from storage; and in recommending proper allocations of the total as between the various oil-producing states, consistent with the provisions of such interstate compact.

4. That the federal government should, under its power to regulate commerce between the states, prevent the shipment in interstate and foreign commerce of crude oil pro-

duced in violation of state law or the refined products thereof.

5. That the federal government should so regulate the importation of crude oil or refined products as to balance production with consumer demand.

Imports should be regulated to some percentage relationship to domestic production so long as this is necessary to effect the balancing of supply and consumption.

Promptly after this report was made to the Cole committee in Dallas by the A.P. I. directors, the officials of the oil producing states got busy and assembled first at Ponca City, Oklahoma, at Governor Marland's home and later at Dallas, Texas, where we entered into a compact as follows:

AN INTERSTATE COMPACT TO CONSERVE OIL AND GAS

ARTICLE I

This agreement may become effective within any compacting State at any time as prescribed by that State, and shall become effective within those States ratifying it whenever any three of the States of Texas, Oklahoma, California, Kansas, and New Mexico have ratified and Congress has given its consent. Any oil-producing State may become a party hereto as hereinafter provided.

ARTICLE II

The purpose of this compact is to conserve oil and gas by the prevention of physical waste thereof from any cause.

ARTICLE III

Each state bound hereby agrees that within a reasonable time it will enact laws, or if laws have been enacted, then it agrees to continue the same in force, to accomplish within reasonable limits the prevention of:

(a) The operation of any oil well with an inefficient gas-oil ratio.

(b) The drowning with water of any stratum capable of producing oil or gas, or both oil and gas in paying quantities.

(c) The avoidable escape into the open air or the wasteful burning of gas from a natural gas well.

(d) The creation of unnecessary fire hazards.

(e) The drilling, equipping, locating, spacing or operating of a well or wells so as to bring about physical waste of oil or gas or loss in the ultimate recovery thereof.

(f) The inefficient, excessive, or improper use of the reservoir energy in producing any well.

The enumeration of the foregoing subjects shall not limit the scope of the authority of any State.

ARTICLE IV

Each State bound hereby agrees that it will, within a reasonable time, enact statutes, or if such statutes have been enacted, then that it will continue the same in force, provided in effect that oil produced in violation of its valid oil and/or gas conservation statutes or any valid rule, order or regulation promulgated thereunder, shall be denied access to commerce; and providing for stringent penalties for the waste of either oil or gas.

ARTICLE V

It is not the purpose of this compact to authorize the States joining herein to limit the production of oil or gas for the purpose of stabilizing or fixing the price thereof, or create or perpetuate monopoly, or to promote regimentation, but is limited to the purpose of conserving oil and gas preventing the avoidable waste thereof within reasonable limitations.

ARTICLE VI

Each State joining herein shall appoint one representative to a commission hereby constituted and designated as THE INTERSTATE OIL COMPACT COMMISSION, the duty of which said commission shall be to make inquiry and ascertain from time to time such methods, practices, circumstances and conditions as may be disclosed for bringing about conservation and the prevention of physical waste of oil and gas, and at such intervals as said commission deems beneficial it shall report its findings and recommendations to the several States for adoption or rejection.

The Commission shall have power to recommend the coördination of the exercise of police powers of the several states within their several jurisdictions to promote the maximum ultimate recovery from the petroleum reserves of said states, and to recommend measures for the maximum ultimate recovery of oil and gas. Said Commission shall organize and adopt suitable rules and regulations for the conduct of its business.

No action shall be taken by the Commission except: (1) by the affirmative votes of the majority of the whole number of the compacting States, represented at any meeting and (2) by a concurring vote of a majority in interest of the compacting States at such meeting, such interest to be determined as follows: such vote of each State shall be in the decimal proportion fixed by the ratio of its daily average production during the preceding calendar half-year to the daily average production of the compacting States during said period.

ARTICLE VII

No State by joining herein shall become financially obligated to any other State, nor shall the breach of the terms thereof by any State subject such State to financial responsibility to the other States joining herein.

ARTICLE VIII

This compact shall expire September 1, 1937. But any State joining herein may, upon sixty (60) days' notice, withdraw herefrom.

The representatives of the signatory States have signed this agreement in a single original which shall be deposited in the archives of the Department of State of the United States, and a duly certified copy shall be forwarded to the Governor of each of the signatory States.

This compact shall become effective when ratified and approved as provided in Article I. Any oil-producing State may become a party hereto by affixing its signature to a counterpart to be similarly deposited, certified and ratified.

Done in the City of Dallas, Texas, this sixteenth day of February, 1935.

E. W. MARLAND
The Governor of the State of Oklahoma

JAMES V. ALLRED
The Governor of the State of Texas

R. L. PATTELSON
For the State of California

FRANK VESELY

E. H. WELLS

HUGH BURCH

HIRAM M. DOW
For the State of New Mexico

This compact has worked wonderfully well. It is based upon the one foundation concerning which there can be no conflict of interests, the prevention of irreparable waste of a natural resource.

Officials and operators may differ over a temporary expedient or rule to apply; they may differ over a temporary objective. They cannot, however, and do not, differ upon the soundness of preventing unwise use of those natural energies by which oil is produced.

Upon this sound and solid basis, we meet quarterly and exchange ideas and experiences in producing oil so as to leave in the sands never to be recovered the very least possible amount of oil.

The imagination of the people most concerned is always strangely more aroused by the potentialities of possible new developments and changes than by the proven abilities of established methods.

This has been true of the constant excited and rumor-infested business of producing oil. You all know the story of the oil man who checked out of Heaven because he heard a rumor of an oil strike in Hell, when he, himself, had started the rumor.

I read in the *Petroleum World,* March issue, that 22 per cent of your operators in California were not coöperating in curtailment. With so large a number out of the plan, I am amazed at your results.

It seems that about the only way some people can learn prudence is to go broke. The sad part is that lack of coöperation will bring the whole house down upon all of us. We have found that your proration rules and formulae must be very simple. Your committee's recommendations seem simple and workable, except I must admit that to a Texan the allowables recommended seem excitingly high.

We have 30,000-barrel wells curtailed to 20 barrels per day and permit only six days operation at that. Our operators would be scared to death if we told them they could produce from 250 to 300 barrels per day. I can plainly foresee that doubtless you here, too, will shortly have to come to ever-decreasing allowables. You will either do it by voluntary agreements or by law, because you will very probably not long be able to sell the oil you are now producing. It looks to me like we are going to have a weak oil market for a long time to come. It is a buyer's market. With the vast amount of oil being produced and the ever increasing number of wells, there is no chance of improvement short of drastic curtailment of drilling.

We have got to average down our costs by spreading them thinner over our oil reserves. If we try to switch the trend of buying by fighting each other, say Texas and California, it can be accomplished only at a sacrifice in price.

I am informed that recently several cargoes of gasoline from California have taken Gulf Coast markets in Europe at a cut of one quarter of a cent a gallon in price. This may or may not be the case, but it does illustrate what I mean. I have heard talk of some Texas refiners getting ready to ship some tankers of gasoline to Seattle and Portland. These are uneconomic movements—taking coals to Newcastle. The oil compact or treaty is the only solution to the very serious problem in which we are involved.

Viewing the markets internationally, I am of the opinion that our foreign markets will grow weaker unless Japan continues her attack upon China or unless there should be a general war in Europe. Venezuela or other South American countries and south central European countries are going to capture a lot of our markets for oil. They are going to produce oil in a big way. We cannot suddenly change the flow of oil and products to markets without sharp repercussions. We had best get together under our compact and work out together our common problem on the basis of reserves and home markets.

It is our hope that we may develop a set of laws, rules, and regulations concerning conservation and proration of oil and gas that will be so reasonable and fair and advantageous to the individual operator as well as the industry that the ready acceptance and observance of them will be almost automatic. Only fully understood, these practices will become the rule and guide of prudent operators.

TECHNICS OF OIL CONSERVATION

By GLENN STALEY [1]

The technics of oil conservation are the principles of good drilling and production practice. In 1935, the Legislature of the state of New Mexico passed a law providing for the conservation of oil and gas. The first two sections of this law read as follows:

> BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF NEW MEXICO
>
> SECTION 1. The production or handling of crude petroleum, oil or natural gas, or the handling of products thereof, in such manner or under such conditions or in such amounts as to constitute or result in waste is each hereby prohibited.
>
> SECTION 2. As used in this Act, the term "waste," in addition to its ordinary meaning, shall include:
>
> (a) "Underground waste" as those words are generally understood in the oil business, and in any event to embrace the inefficient, excessive, or improper use, or dissipation of the reservoir energy, including gas energy and water drive, of any pool, and the locating, spacing, drilling, equipping, operating, or producing of any well or wells in a manner to reduce or tend to reduce the total quantity of crude petroleum oil or natural gas ultimately recoverable from any pool.
>
> (b) "Surface waste" as those words are generally understood in the oil business, and in any event to embrace the unnecessary or excessive surface loss or destruction without beneficial use, however caused, of natural gas, crude petroleum oil or any product thereof, but including the loss or destruction, without beneficial use, resulting from evaporation, seepage, leakage, or fire, especially of spacing, equipping, operating or producing, well or wells, or incident to or resulting from the use of inefficient storage or from the production of crude petroleum oil in excess of the reasonable market demand.
>
> (c) The production of crude petroleum oil in this State in excess of the reasonable market demand for such crude petroleum oil. Such excess production causes or results in waste which is prohibited by this Act. The words "reasonable market demand" as used herein, shall be construed to mean the demand for such consumption and use within or outside the State, together with the demand for such amounts as are reasonably necessary for building up or maintaining reasonable storage reserves of crude petroleum oil or the products thereof, or both such crude petroleum oil and products.

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[1] Umpire, Lea County Operators Committee, Hobbs.

Before going into the details of the procedure followed in eliminating waste as outlined in the above sections, it may be well to give a brief outline of the general methods of operation in effect some twenty years ago. In absence of the necessity for control of production, to reduce waste, the theory under which the industry operated was that an owner was entitled to oil produced from wells on his own property. Consequently, wells were drilled without taking into account proper spacing or distances from property lines; and all wells were produced to capacity.

Under the old unrestricted production methods, the effect of this was to give each operator the right to produce the recoverable oil under his land, with the important povision that the operator himself was responsible for the protection of this right, which could be accomplished by drilling the number of wells necessary for this purpose.

Now that it has become necessary to restrict petroleum production in the interest of conservation for the benefit of the public as well as the economic welfare of the industry, it has become necessary for the state to regulate the right of the operators to protect their own property from drainage by their neighbors, and thus assume the obligation of maintaining the privileges which were formerly enjoyed. This is being done by the application of proration, or allocation plans of production among pools and wells within a pool.

Conservation and prevention of waste in the production of oil cannot be realized without curtailment. If the full benefits of conservation are to be realized the plan of proration must be equitable, reasonable, and wisely administered.

Returning now to subhead "(a)" under Section 2 of the law, we find the title "Underground Waste"; this term includes dissipation of gas energy and water drive, locating, spacing, drilling, equipping, operating, or producing of a well in such a manner as to reduce the total quantity of crude petroleum oil or natural gas ultimately recoverable from any pool.

Ultimate recovery depends primarily upon the energy available to bring the oil to the wells and the efficiency with which this energy is used. The source of this energy lies in the compressed gas associated with the oil and water underlying the oil and pressing upward upon it. Oil will not migrate to the well unless it is moved by the force of one or both of these fluids. The ability of these fluids to produce oil is measured by the pressure that they exert which is called the "reservoir pressure."

The maintenance of reservoir pressure conserves the energy necessary to produce oil, and at the same time causes the oil to retain desirable physical characteristics such as low viscosity and low surface tension so that loss of this energy is required to produce each barrel of oil. This inevitably increases ultimate recovery; hence, maintenance of reservoir pressure must be one of the most important steps to be taken in securing maximum yield of oil, economically. If restriction of production results in maintenance of pressure it must increase the recovery of oil.

The next factor to be considered is well spacing. As noted above, nature has supplied powerful forces to aid in producing oil under restricted flow. An engineering study indicates that these forces can be utilized to the best advantage when fields are depleted in a period of about twenty or twenty-five years. It is a remarkable coincidence that economic considerations also demand a similar degree of curtailment. It is, unfortunately, impossible to estimate accurately the increased recovery that can be obtained through the efficient methods made possible by controlling rates of production. However, the information available indicates that modern methods will yield a minimum of from one-third to one-half more oil than could be obtained under the old practice of unrestricted production, and many engineers are of the opinion that recovery can be doubled or trebled. Production costs can probably be reduced one-third of the cost under older methods. The saving in production costs is due primarily to two factors: first, a reduction in the number of wells required to drain the reservoir efficiently; and second, a lowered lifting cost brought about by a prolonged flowing life. The area drained by a well is greater if the well is produced slowly, the reason being that the minimum amount of gas is allowed to come out of solution while moving toward the bore hole. Hence, fewer wells will be required.

In the state of New Mexico, the unit of production for proration purposes is forty acres, as set out by the Oil Conservation Commission. There is no restriction as to the number of wells that can be drilled thereon.

The next factors to be considered under subhead "(a)" are drilling, equipping, operating, or producing any well or wells in a manner to reduce or tend to reduce the total quantity of crude petroleum oil or natural gas ultimately recoverable from any pool.

Well drilling is an ancient craft although comparatively a modern industry. The business of drilling wells for petroleum has spread to every part of the world, and has developed into one of the foremost industries in the United States, requiring the services of a vast army of experienced production men, drillers, petroleum engineers, and geologists. Prior to the advent of the technical man into the drilling branch of the oil industry, all problems were taken care of by the practical driller and a great deal of credit must be given him for the ingenuity and resourcefulness used in overcoming the many difficulties and unforseen obstacles.

Today geology plays an important part in well drilling. A detailed study of the rock formations, stratigraphy, and examination of well cuttings while the well is being drilled, is necessary to determine the drilling equipment best adapted to the locality and determine the points at which the various strings of casing are to be set.

The Oil Conservation Commission, with the assistance of the oil companies, has made up casing programs for the various pools within the state. These programs, if followed by the operators, will adequately protect the area surrounding the well. Care has been used in working up these programs, so that in each case gas, oil, and water cannot migrate from one horizon to another.

In some oil pools there was originally a large area of free gas above the oil. Wells at the crest of the structure may produce nothing but gas. Some wells down structure go through the gas and then into the oil sand. The free gas in the structure is an important factor with reference to the recovery of the oil. If undisturbed it prevents the oil from rising into the dry, unsaturated sands and tends to hold in solution the gas which is dissolved in the oil, thereby maintaining the viscosity of the oil so that less energy is necessary to move it. Again the production of dry gas by reducing the pressure in the reservoir permits the oil level to rise so that the oil saturates the dry sands and only an insignificant part of it can ever be recovered. Great waste of oil occurs. When the drilling of initial wells in a pool indicates that the above condition exists the casing program and well completion practice should be such as to preserve this gas cap. Through the examination of well cuttings and insoluble residue, impervious horizons can be located in the well bore, by the geologists and engineers. By setting packers at these points the oil and gas may be produced separately. In many cases it has been possible to produce only the gas that is dissolved in the oil only from wells situated in areas having free gas caps.

The accepted definition of the term "gas-oil ratio" is the number of cubic feet of gas produced with each barrel of oil from the reservoir. Low gas-oil ratios and controlled production go hand in hand.

Practical methods for controlling gas-oil ratios usually depend upon reasonable restriction of the field's production. Without restriction of production there is no opportunity to use methods for conserving gas and energy.

Subhead "(b)" of Section 2 of the Oil Conservation Act specifies "surface waste." Under this heading, loss may be incurred resulting from evaporation, seepage, leakage, or fire. Manufacturers of oil field equipment working under the direction of petroleum engineers and other oil field technicians have made great strides in the perfecting of high pressure well-head equipment, high pressure casing, tubing, valves, chokes, gauges, and many other devices used in the production of oil. Oil well blowouts, due to defective equipment are becoming extremely rare. Thousands of dollars are being spent every year by the manufacturers of steel in an attempt to determine the cause of corrosion and methods of preventing it.

The United States Bureau of Mines has made exhaustive tests regarding evaporation of the lighter fractions of crude oil that had been in storage for various lengths of time. They find that the loss of these lighter fractions is negligible, where modern storage tanks are used.

Extreme care is used by operators in locating production tanks in the field from a standpoint of fire hazard and leakage.

Under subhead "(c)" of Section 2 the production of crude petroleum oil in this state in excess of the reasonable market demand for such crude oil is prohibited. The words "reasonable market demand," as used herein, shall be construed to mean the demand for such consumption and use within or outside the state, together with the demand for such amounts as are reasonably necessary for building up or maintaining reasonable storage reserves of crude petroleum oil or products thereof, or both such crude petroleum oil and products.

As stated above, prior to the time when proration was generally applied to hold oil production within reasonable limits, wells were produced at their full capacity; that is, at 100 per cent of their open flow potential.

Operating methods have changed in recent years, first due to economic circumstances which no longer permit the unrestricted flow of wells, and finally, because of the experience gained in the operation of restricted fields, it was recognition of the fact that wide open flow is not in accord with good engineering practice and contrary to the principles of conservation.

The proration of oil in a given pool or area is necessary where the market outlet is less than the pool's ability to produce. In such pools, it can be said that the production is curtailed. The reason for curtailing production may be to meet the market demand, to conform with a state-wide or nation-wide proration program established by governmental agencies, or it may be purely voluntary.

Mr. T. V. Moore, of the Humble Oil and Refining Company, in his paper, "The Effect of Curtailment on Ultimate Recovery," states that "the primary purpose of any proration plan should be: first, to prevent waste of all kinds; second, to protect the vested rights and equities of all owners of petroleum resources; third, within the limits prescribed by conservation and the proration of property interests to permit operators to develop and produce oil fields in the most economical manner." Therefore, it can readily be seen that there is a direct connection between proration and oil conservation.

No major oil field that has been produced at its most efficient rate has yet been forced to resort to pumping a majority of its wells.

If an entire field could be operated as a unit and nothing but engineering problems were involved the solution of the problem would be comparatively simple.

The date of discovery of oil in New Mexico was 1909; in what is locally known as the "Old Brown Well," but it was not until 1930 that there was any necessity for curtailment for proration. This was brought about by the discovery of the Hobbs pool. There being no regulatory body in the state at that time, the operators themselves agreed upon a plan of proration in which they were joined by the state land commissioner and the plan was approved by the state geologist, as required by law. The oil companies continued to operate under a voluntary proration agreement among themselves until the 1935 conservation statute went into effect. Also established at the time this voluntary agreement was reached was an Engineers Advisory Committee, composed of one engineer from each company operating in the district. The purpose of this committee was to gather data pertaining to drilling and production practice and make recommendations to the operators as to the procedure to be followed in correcting conditions that tended to dissipate reservoir energy and decrease ultimate recovery. This committee (which is still in existence) has supervised the installation of packers for reducing gas-oil ratios, and water encroachment, sub-surface pressure surveys to determine the loss of reservoir pressure, in relation to the amount of oil produced, outlining of casing programs, total depths to which wells should be drilled, and the taking of sub-surface temperatures to determine casing leaks, and gas-oil contacts; this body has also made recommendations with regard to high pressure well equipment.

The Hobbs pool is an example of what can be accomplished through coöperation of all operators and state regulatory bodies. This field has produced approximately 86,000,000 barrels of oil since January 1, 1930, with a loss in reservoir pressure of approximately four pounds per million barrels. A drop of only 2.9 pounds per million barrels has occurred during the past year, thus indicating the results of continued conservation.

Another indication of maintenance of reservoir pressure is the fact that there have been 252 wells drilled in this field of which only about ten are pumping; the balance are still making their production by natural flow.

The splendid results obtained by doing remedial work in the Hobbs pool have led the operators to continue this practice in other fields in southeastern New Mexico. To a great extent, corresponding beneficial results have prevailed in these other fields. Approximately half a million dollars has been expended in southeastern New Mexico pools for the setting of packers and performing of other remedial measures. The conservation, through the practice of extracting gasoline and butane from natural gas produced with the oil, is being followed in many of the fields in New Mexico.

The Oil Conservation Commission has seen fit to encourage the remedial work or the working over of wells in order to conserve reservoir energy by allowing operators to make up production lost while the well was undergoing such work.

In discussing the technics of oil conservation we are faced with a condition, not a theory. The ideal proration plan would be one that would give to each owner of oil and gas properties within a pool the exact number of barrels of oil underlying his property. But we cannot change the peculiar natural characteristics of oil and gas deposits. We cannot reconstruct subsurface conditions by building walls within the reservoir along property lines. If we could do that and should do so we would at the same time destroy, in large part, the great value of reservoir energy in the recovery of the oil. Nor can we hope to eradicate the natural craving of man to gain advantage over his fellow beings when opportunity presents itself.

DISCUSSIONS

By E. A. WAHLSTROM [1]

Mr. Staley has presented an excellent discussion of the general principles involved in the conservation of oil and gas. His use of the New Mexico statute providing for the conservation of oil and gas in the state of New Mexico as the basis of his paper is very appropriate, since the oil industry as a whole has found the New Mexico Conservation Law to be a model of legislation for the conservation of gas and oil. The oil operators in New Mexico have found the application of this law to be reasonable and practical. This statute and the regulation of this statute can be given a large amount of credit for the development of the oil industry in New Mexico.

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[1] Field Engineer for the Goldsmith Pool, Midland, Texas.

As Mr. Staley has pointed out, the proration of oil and gas between fields and wells is a conservation measure. It is generally agreed that unit operation or unitization is the ideal method of producing an oil field with the minimum amount of physical waste. Proration between wells in a field should be an attempt to approach unit operation of an oil field. This has been accomplished by unit plans of drilling and producing an oil field after the pooling of the individual properties in the field. This ideal method of drilling and oil production is required by the United States government for the exploration and development of oil and gas on the public domain.

An ideal plan of conservation and proration requires each field to be produced at the most efficient rate of flow with the minimum amount of physical waste. The two indexes of efficient rate of flow are gas-oil ratios and bottom hole or reservoir pressures. The efficient rate of flow of a field obviously requires that each individual well in a field be produced with the minimum gas-oil ratio and the minimum drop in reservoir pressure. The efficient production of an oil field can be compared to the performance of an automobile engine in that the operator must watch the gas consumption and the oil pressure of his engine to obtain the most efficient operation.

Pressure maintenance or the practice of returning gas to the formation to maintain reservoir pressures is recognized as a real conservation measure and should find wider application in the future. The ideal production method should include a pressure maintenance program, returning unused gas and oil products to the reservoir at reservoir pressure.

Secondary recovery methods such as re-pressuring depleted pay formations with gas and the use of water to flood depleted sands are conservation practices in wide use to recover oil not recovered by ordinary flowing and pumping methods.

Mr. Staley discussed the fact that by the use of conservation practices fewer wells are required to efficiently drain the oil from a reservoir. The New Mexico Conservation Commission is commended for recognizing this fact with their wide spacing orders in Lea County, New Mexico.

By R. A. KOENIG [1]

It is difficult to define items of conservation having direct geologic bearing as this phase of the business is interlaced with many important engineering and production problems. However, company geologists are often called on for opinions and decisions on matters pertaining to: (1) Locating of individual wells to the best advantage from a producing standpoint. (2) Casing points for protecting surface waters, the salt section, and for dividing the free-gas reservoir from the oil zone. (3) Analyses of sand cuttings, cores, drilling time and Schlumbeeger logs, geophysical interpretations, and peculiarities of other wells in similar pools. (4) Safe completion depths above the water table, which otherwise might necessitate deepening or plugging back. (5) Additional or rework jobs as acidizing, shooting of perforating. Also choosing of packer points for segregation of oil, gas, and water, or for reducing gas-oil ratios, which are necessary to conserve reservoir energy and maintain natural lift. (6) Structural pictures as shown on contour maps. (7) Anticipated ultimate recoveries per acre, relative pool drainage by individual wells and proper spacing to obtain the maximum of oil at a profit.

GEOLOGICAL PROCEDURE

There are no two wells exactly alike as to stratigraphy so that each test is a problem. Lateral, sedimentary gradations are mainly responsible for structure and influence porosity and permeability between the penetrated sections within the gas and oil reservoirs.

Geologists, in New Mexico, have always coöperated among themselves, and on conservation problems they, as a group, have assisted in drawing pool maps and in estimating recoverable reserves as indicated by (a) thickness of pay section, (b) effective porosity, (c) permeability, (d) potentials (related to bottom hole and flowing processes), (e) character of producing formations whether lime, sand, or combinations of the two, (f) similiarity to other pools in which more data is obtainable.

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[1] Geologist for the Ohio Oil Company, Hobbs, N. M.

CONCLUSION

This type of study, by various groups under efficient direction has shown valuable results and has reacted beneficially to all of the operators and producers.

By EDGAR KRAUS [1]

Mr. Staley's paper so excellently covered the subject that no formal discussion of it seems necessary.

It is noteworthy, however, that neither his paper nor any of those dealing with conservation that had preceded it made any mention of the prohibition of production or use of this natural resource. Years ago, as many of you will remember, conservation carried that thought to many people, and there was much discussion concerning the need of preserving our natural resources for future generations. We have learned not to worry so much about those future generations for two reasons: There seems to be plenty of petroleum to take care of some future generations, which better methods and deeper drilling will make available when needed; then, too, the future generations may find other fuels or sources of energy more adaptable to their use than those we now deem so desirable.

There is more difference of opinion with regard to conservation as applied to use. There are some who believe that any profitable use is proper. At the other end of the scale are those who think that only the most efficient use as measured by all developed and known methods and engines gives proper conservation. Somewhere in between these two extremes is the most commonly accepted viewpoint.

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[1] Geologist and engineer for the Atlantic Refining Company, Carlsbad, New Mexico.

I should also like to point out and clarify the matter of well-spacing as applied to New Mexico conditions. The New Mexico law does not prevent an operator from drilling as many wells as he wishes on a tract, provided he stays the required distance from the property lines. The law and the regulations applying to it merely establish a forty-acre unit which is the basis of all proration allocations. Allowables are based on this unit and not on the number of wells. This enables the operator who thinks that one well will drain the unit to stand on that conviction even though offset by an operator who feels that more than one well is necessary to accomplish the same purpose. The first operator is not forced to drill additional and, in his opinion, unnecessary, wells, since the allocation of production is based entirely on the unit and not on the number of wells drilled on it.

New Mexico will be an extremely valuable proving ground for the determination of proper well-spacing, especially in lime pools.

NEW MEXICO'S CONSERVATION ACHIEVEMENT

By HIRAM M. DOW [1]

There is an increasing sentiment throughout the oil industry that the achievements of New Mexico in conservation have been outstanding and that she has contributed in a notable degree to the solution of the many intricate and important problems that have arisen along with a growing and nationwide over-capacity to produce.

In view of such liberal praise, it might be well to examine critically the nature of these achievements, the causes from which they spring, their justification, and the good or evil that has come out of them.

The producing history of New Mexico covers some sixteen years. The developments during the first half-dozen

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1. New Mexico representative, Interstate Oil Compact Commission, Roswell.

years of this period were not spectacular, although her production exceeded a million barrels as early as 1925, and had climbed to two million barrels in 1929. Her real importance as a factor in the oil industry of the United States might properly date from the rapid development which took place in the Hobbs pool in 1930. With the exception of the three depression years following this, development has been at a rapid rate, and today the state is producing 35,000,000 barrels annually and is credited with developed reserves of well over 600,000,000 barrels.

For the purpose of this paper the brief history just noted is important in that a close parallelism may be observed to exist between New Mexico's producing history and the evolution of her statutory control.

Quite naturally, before the days of any appreciable development, the lack of problems rendered specific legislation unnecessary. The conservation statute of 1909 did little more than create a conservation commission empowered to make "surveys" and collect data concerning the natural resources of the state, directing that the professor of geology at the University of New Mexico be made the chief of the division of geology on the commission.

Following the first production of consequence, in 1924, the 1925 Legislature passed a bill under which a "State Geologist," appointed by the governor and acting under the authority of the land commissioner, was authorized to make conservation rules governing the development and production of oil and gas. The same statute made applicable within the state the regulations of the Bureau of Mines and the regulations of the secretary of the interior for federal lands under the National Leasing Act of 1920.

On the heels of the discovery of the prolific Hobbs pool in 1928, with the attendant necessity of drastic curtailment of production, an emergency bill was passed in the final hours of the ninth Legislature, in 1929, authorizing coöperative plans of development and production subject to the approval of the state geologist if on private lands and of the land commissioner if on state lands. This made lawful the subsequent Hobbs proration agreement, signed by all of the operators and approved by the state.

This system of proration by agreement worked reasonably well, but it became patent that the rapid increase in the number of pools in Lea County warranted the enlargement of existing legislation into a comprehensive conservation statute, and the 1935 session passed the model law now in effect. It is with the far-reaching effects of this statute that we shall be primarily concerned.

Before passing to the specific nature of the statute it is worthy of observation that its provisions put the stamp of approval upon operating practices and concepts of equity that had evolved naturally under a condition wherein the operators had had the opportunity of solving their problems coöperatively and under a minimum of legislative control. Economic exigencies had demanded fairly wide spacing, and New Mexico had become more or less a proving ground for the placing of single wells on forty-acre units. The operators had also been allowed to attack their many other problems of waste under a minimum of supervision, and it may be said that they did so in a vigorous fashion, attaining an operating efficiency that was noted throughout the industry and proving in a measure the ancient adage that "that government is best which governs least."

We have said that a parallelism existed between New Mexico's oil history and the growth of her body of conservation law. Compared to the statutory evolution in other oil producing states, no such parallelism can be found, and in this regard the 1935 statute was years ahead of its time.

Its main points of departure from existing laws elsewhere were its basis of allocation between the properties within a pool or field, the manner in which it dealt with unnecessary wells, and its specific treatment of the problem of wells located on fractional units.

With regard to allocation between properties within the pool, the law provided that, subject to practicability and the limitations of waste, each property should be allowed to produce substantially in proportion to its recoverable oil.

The second forward step, that relating to the drilling of unnecessary wells, was the pronouncement of the principle that no operator should be required directly or indirectly to drill more wells than reasonably necessary in order to secure his proper part of the production, and to this end provision was made for the fixing of proration units for each pool, such being the area which could be efficiently and economically drained by one well. The law stated further that the drilling of unnecessary wells is conducive to waste and increases unnecessarily the cost to the operator and hence to the ultimate consumer. The inclusion of these economic aspects is thoroughly sound from a waste standpoint, for it has been clearly demonstrated in Texas that the drilling of an excessive number of wells in a pool invariably leads to an aggregate pool allowable above that necessary to the conservation of energy through the utilization of water drive.

The third principle, dealing with pooling and the method of allocating to wells on tracts of smaller than unit size, authorizes both the pooling of properties where agreed upon and even the requiring of the same by the commission. In cases where such pooling should be neither authorized nor required, the allowable of a well drilled on such fractional unit was to be limited to the relationship between its acreage and that of the unit.

All of the provisions cited would demand that allocation be based chiefly upon sand thickness and acreage rather than upon potential or number of wells.

One might wonder why proration based upon such a simple concept of property rights should be considered a departure from current ideas. One might also ask why the use of potential in allocation should not achieve the ends desired.

The second question is intimately associated with, if indeed it does not explain, the first. The answer to both questions lies in the sequence of events wherein a basic misconception arising out of open-flow experience was wrongfully carried over and applied to proration under conditions of controlled rates of flow.

Theoretically, in the days of wide-open production, prior to 1927, an operator secured, or at least was given the right to secure, his fair share of the oil in place. It was felt that a man could effectively protect his property by drilling a ring of offset wells around it. Little work had been done and little data collected on porosity, permeability, the measurement of pressure decline, water drive, connate water, and a host of other related problems. Above all that was known about any reservoir was deduced from the rate at which it produced oil and subsequently went to water. It was observed that, in general, large wells produced more oil ultimately than small wells. The future recovery of a property of settled production was estimated by projecting ahead its apparent rate of decline, and from this arose the practice of buying and selling oil properties at so many dollars per barrel of daily production. It was observed that the daily production of wells in closely drilled areas diminished more rapidly and the wells went more quickly to water than those in the more widely drilled areas. When a well produced too much water to allow it to pay its way it was abandoned; if a well started producing a high percentage of gas, no attempt was made to shut it in or otherwise correct the evil. Things were relatively simple, and if profligate waste could be ignored, no one seemed to be unduly at the mercy of the system.

With this inheritance for a background, it was perhaps natural that early attempts at proration were based largely upon open-flow potential. It was not long, however, before the fallacy of this became apparent to a majority in the industry. An examination of production records had already revealed that even under open-flow the relationship between a well's daily capacity and its ultimate production was, at best, sketchy and that on the average a 10,000-barrel mid-continent well would produce ultimately only from two to three times the amount of a 1,000-barrel well. In the face of this common knowledge, the false assumption led even to the granting of wells on a tenth of an acre as much allowable as wells on ten acres, e.g., the east Texas field. There are many such small tracts today which have already produced several times the quantity of oil conceivably beneath them, although their potentials are not much below their initial potentials and equal to those of wells nearby on tracts which have produced not more than a hundredth as much oil per acre-foot. The reasoning behind this second and crowning fallacy was this. Under open-flow conditions some additional oil per acre was secured from tracts by virtue of their having been drilled more densely than others. Hence, more wells, more oil; more oil, less waste, and therefore the operator with ten wells on forty acres should be rewarded by getting ten times the allowable of the operator with but one well. The fact was overlooked that the richest parts in the field were ordinarily drilled the densest and that the prolific pools were drilled more densely than those with less abundant reserves per acre. Moreover, the fact was also lost sight of that the operator with many wells on a forty secured this additional oil largely at the expense of his more conservative neighbors.

But let us admit that some additional oil *was* secured by virtue of close drilling in the days of wide-open flow, and examine the possible reasons for such a situation. Two explanations come to mind: the rapid depletion of energy by gas wastage and the trapping of oil between wells due to irregular water encroachment. The first must assume, to begin with, that considerable energy is dissipated in moving oil through the formation and hence that the shorter distance the oil has to travel to get to the hole the more efficient will be the operation. In connection with this let us consider a specific case. The Conroe field, in Texas, has twenty-acre spacing. The average barrel of oil underground contains over six million foot pounds of energy in its dissolved gas.

such energy being due to the fact that the mixture is under high pressure. Less than one hundred additional foot pounds of energy are needed to move the oil to the hole than would be necessary if the wells were on ten-acre spacing. As a matter of fact, no energy at all can be saved by close spacing, for once a barrel of oil gets to the bottom of the hole, all of its remaining energy must be dissipated as the oil travels from this point up through the tubing and into the stock tank.

The second reason sounds more plausible. High rates of flow can cause large drops in pressure around the bottom of a well and in turn tend to create coning of bottom water and irregular encroachment of edge water. Conceivably then, under open-flow conditions, a multitude of wells can recover more oil from a pool than can fewer wells. These conditions, fortunately, do not obtain under conditions of proper curtailment, for the daily rate of flow can be obtained from bottom hole pressure drops of a few pounds or in some cases a few ounces and the level of encroaching water becomes the same mid-way between the wells as at the wells themselves.

The economic significance of unnecessary drilling to the country at large presents food for thought. In 1937, a committee of the Independent Producers Association reported that the cost of unnecessary drilling in the United States totalled between eighty-five and one hundred million dollars annually. Competent observers, both engineers and producers, estimate that the economic waste in the East Texas field alone, caused by over-drilling, has reached the fantastic total of two hundred million dollars. It is the absence of such waste in New Mexico that largely accounts for the rapid yet sound development of her oil reserves.

The wise control of drilling and production exercised by the Conservation Commission under the 1935 statute has been almost as important as the statute itself. Its fostering of a wide spacing program has been largely responsible for the search for new pools and the consequent reserve position of New Mexico in the national picture. Had a ten—instead of a forty—acre program been adopted, either by order or common consent, as a standard, the high resulting costs and the lack of any reasonable profit would have certainly checked development to an alarming degree.

There is, moreover, a definite relationship between the reserves in a pool and the proper pool allowable from the standpoint of waste. With close drilling the developed acreage would have covered a small area and the waste-peak allowable for the state would have been much smaller than the one hundred thousand barrels it produces daily. The slow rate of decline of reservoir pressures in the Hobbs pool indicates that it is being produced less wastefully than is the average ten-acre pool in other parts of the Permian basin, leading to the conclusion that the presence of more wells would not only be unnecessary but probably harmful. This observation has also been borne out in Texas, where the widely spaced pools have the best conservation record.

An interesting commentary on efficient recovery and excess drilling is to be found in a study relating to petroleum economics, written by Dr. Joseph E. Pogue, an eminent petroleum economist and vice-president of the Chase National Bank, New York. Dr. Pogue observes:

> Efficient recovery: The ideal way to produce an oil field is to restrict the flow to a rate that results in the most effective utilization of the reservoir energy. In this manner the greatest practicable recovery of the oil is achieved and resort to pumping is deferred until near-exhaustion of the deposit. The form of the reservoir energy is complex, varying from pool to pool, but it is generally represented by the driving power of edge- and bottom-water under hydrostatic pressure and the compressed gas associated with the oil. The energy inherent in the gas manifests itself as a propelling force available upon the release of pressure, and the dissolved gas renders the oil more liquid and reduces the tendency to stick to the sand grain. *Fortunately the beneficial effects of water drive and associated gas can be maximized by adjusting the flow to the most efficient or optimum, rate, which is subject to more or less exact determination if suffi-*

cient engineering effort is devoted to the matter. (Italics mine.)

Excess drilling: With the establishment of proration . . . two new factors appeared; it was discovered that the conservation of reservoir energy was a partial substitute for drilling; since under pressure-maintenance methods fewer new wells are needed than under open-flow practice; and it became apparent that if the rate of production is to be restricted and therefore, the pay-out period lengthened, then a concomitant spreading out of the investment period should likewise be provided for. Both of these considerations in the course of the past few years have entered the consciousness of operators, and have even received the cognizance of the regulatory bodies, as exemplified in well spacing rules in many pools and insistent discussions of the subject at Commission hearings. But by and large the drilling concept is less advanced than is desirable; and the principle that the State fails to do equity if it compels deferment in oil withdrawals without at least making it possible for the operator to retard his investment commensurably is yet to be established, although the matter appears to be getting close to that stage.

As a result of this unadjusted element in the handling of proration unnecessary wells in great numbers have been drilled in the past few years and the allowable production per well has declined to the point where the whole subject is coming in for active attention. Expressed in other terms, production has been largely divorced from the effects of the rule of capture, but drilling has not been freed from this influence in equal degree. In the administration of proration the well rather than the underlying oil reserve, has usually been accepted as the ultimate unit for allocation of demand. This policy creates artificial incentives not only for drilling more wells than are necessary to extract the oil but also for drilling in advance of economic requirements, and hence capital is employed prematurely and in unnecessary amounts. *The maintenance of equity amongst operators and balance in capital flow can be effected through the recognition of the available oil as the unit of proration and the utilization of this factor as the basis for lease allowable.* (Italics mine.)

In this manner the pressure to drill unnecessary wells would be reduced promptly and the conservation of capital made an essential by-product of the conservation of oil. Once this is done, some of the most perplexing difficulties now plaguing the regulatory bodies and the oil operators will be resolved.

Under the operation of salutary conservation laws in the states of Oklahoma, Texas, Louisiana, Kansas, and New Mexico, and recent enactments in Arkansas and Michigan, the spacing of wells is, or may be, controlled, the rate of production from fields is regulated, and the production within the state is, in the main, limited to market demand with allocations of the allowable between pools and within the pools between wells and properties. *These methods, while accepted by some as measures for stabilization are, in fact, grounded primarily and fundamentally upon the prevention of actual physical waste.*

There are three ways of measuring waste in an oil field: the rate of drop in bottom hole pressure, gas-oil ratios, and irregularity of water encroachment. Using these three criteria it can be demonstrated that less waste is occurring currently in the widely spaced pools than in those which have been spaced closely. Actually, on the basis of waste under controlled production, it might be more logical to penalize, rather than reward, the close spacing of oil wells.

Not all of the above was immediately apparent to those engaged in prorating oil fields, but inasmuch as the simplest logic could demonstrate that gross inequities were occurring under the almost unrestricted use of potential, combination formulae began to be used, one of the most common of which was acreage plus potential, wherein one-half of the pool allowable was assigned to acreage and one-half to potential. Where the spacing was uniform this worked reasonably well, but its use still allowed a well on a city lot to produce over one-half as much as a well on forty acres, although the recoverable oil under the first tract might be but one four-hundredth of that under the second. In a few cases, a further refinement was added and the formula became acreage plus acreage times potential (A+AP). This was a very distinct advantage, for it not only dampened the effect of potential but also confined such dampened potential to the acreage of the tract. Of course, with even spacing of wells the second "A" cancelled out. The main weakness of the formula was that it presupposed that variations in potential were due to differences in sand thickness, which was more often invalid than true. However, due to the greatly diminished role played by potential in this formula, no considerable imparities could occur and at worst it was, on the average, many times as precise as the customary A+P formula.

From the above it is clearly apparent that despite the lack of statutory aid, some progress had been made toward a solution of the allocation problem.

One besetting difficulty of the proration problem lies in the fact that in almost any oil pool waste can occur with or without equity, and equity can be achieved with or without waste. The New Mexico law takes cognizance of the first premise by stating that equity must yield to the reasonable limitations of waste. It takes account of the second by providing for pooling and unitization agreements among the operators. Only under a plan of unitization can a maximum of both conservation and equity hope to be achieved, for the problems of waste and equity arising out of edge water encroachment and the expansion of gas caps render an optimum condition almost impossible under a reasonably simple and practical formula. No law, of course, contemplates that absolute justice can ever be achieved, but, as does the New Mexico statute, it can at least set out a proper goal toward which to strive.

The formulae used in New Mexico are not perfect; probably better ones can and will be devised. At any rate, it may be said that the coöperative efforts of the commission and operators in carrying out the intent of the law have represented a great step forward.

The effect of the New Mexico law and the practices resulting therefrom on the other oil-producing states has been phenomenal. Three important oil-producing states, viz: Arkansas, Louisiana, and Michigan, have enacted similar conservative legislation. In but few particulars do the laws of those states vary from the New Mexico statute. They provide for allocation based upon oil in place with an additional clause to the effect that the order shall minimize reasonably avoidable net drainage between properties. The added clause is good in general and should prove helpful, although it is not vital and may, at times, even prove cumbersome. Provisions in the laws regarding the drilling of unnecessary wells and the proper size of the drilling units are the same, with the exception of the inclusion of the word "maximum," to wit: ". . . a drilling unit shall be considered as the 'maximum' area that can be efficiently and economically drained by one well." Provisions for pooling and the treatment of fractional units are practically identical with those of the New Mexico statute.

This, together with the essential similarity of pending legislation in the legislatures of Illinois and Mississippi, with the New Mexico statute, is assuredly an interesting commentary on the adequacy of the New Mexico law as tested by four years of actual operation.

There can be little question but that the operating practices deriving from the law have had an effect upon the industry in general. Certainly the rapid spread of forty-acre spacing in West Texas is partly a result of the success of its operation in Lea County, New Mexico. It is rational to assume, moreover, that the reasonableness of the proration formulae used in New Mexico has hastened the decreasing of the weight of potential in the formulae used in other states.

It was quite natural, with such categorical concepts of equity expressed in her conservation law, that New Mexico should have taken a rather prominent part in the Interstate Oil Compact movement, for it is only a step from the concept of equity between wells to that of equity between pools and states. New Mexico went into the compact, furthermore, with a past record of sound conservation and could speak with authority concerning the main objective of the organization—the prevention of waste. Thus through the media of the compact meetings as forums of discussion, the healthy condition of the industry in New Mexico, despite the high degree of production control in her oil fields, became widely known and destined to have a profound influence upon those few states which have adopted courses less consonant with conservation efforts.

So far in our study it would appear that New Mexico's policies in the handling of her oil affairs have been progressive, justified from the standpoint of waste and equity, and helpful to the conservation program throughout the nation.

Let us turn to the effect of these policies upon her internal economy. Have they been merely gestures of altruism or are they also sound from the standpoint of business acumen? As a background to our analysis, I feel that we should first take cognizance of the fact that the oil business is highly competitive, both between business units and geographic units. It is natural that areas wherein the certainty of reasonable profit is most assured are preferentially exploited. High development costs and a relative inaccessibility of markets confronted New Mexico from the start. Close spacing and consequent small per-well allowables would have proved unprofitable to the extent of discouraging the influx of capital. Accordingly, New Mexico not only fostered a forty-acre spacing program but also saw to it that each operator was allowed to produce his fair share of the oil. Almost entirely due to these policies, the oil industry in the state is flourishing, growing apace, and on as solid a foundation as that of any other state. The direct income to the state from the oil industry, less gasoline taxes, is well above five million dollars per year. Thousands of people living in model towns have been drawn into hitherto unpopulated areas. The total yearly spending of the oil industry within the state is about thirty million dollars. Oil plays a larger part in the economic situation of New Mexico than it does in any other state.

New Mexico also produces more oil than any other state per barrel of gasoline consumed within the state. This is more or less a corollary of the ratio between production and population, but it indicates rather clearly the dependence of New Mexico upon markets beyond its borders. Her markets, moreover, are not within easy reach. To the northeast, east, and southeast it is bordered by important oil producing states. To the north the Rocky Mountain area is partially served by the production from Montana and Wyoming. Important refineries exist at both Denver and Casper. To the west is a sparsely populated area adequately served in the main by west coast refiners. Her natural outlet is southward to the gulf, where, en route, it must compete with west Texas crude. To have successfully competed in the face of such natural disadvantages is but further testimony as to her regulatory wisdom.

In still another, and very important, particular New Mexico leads the oil producing states. She is first in the percentage of flowing wells, inasmuch as her wide spacing program has afforded her an adequate backlog of reserves behind the production from her wells. This has allowed unit costs to be kept at a level which has served to attract investment capital which would otherwise have gone to more favorably located areas.

Although New Mexico's place in the national picture is not overly large from the standpoint of barrels, nevertheless she is fifth among the twenty-two oil producing states on the basis of reserves, and it is quite possible that she may move ahead of Louisiana and Oklahoma to third place within the next five years.

Based upon her total production for 1938, New Mexico ranked sixth in the nation and would have ranked fifth had it not been for the fact that the major part of the allowable of Kansas was absorbed by its thousands of stripper wells.

In keeping with her other conservation efforts, New Mexico has kept her production reasonably within the limitation of market demand. This has caused increased efficiency in the operation of her pools, which, in turn, will enhance their ultimate production. Already her proven reserves represent more than eighteen years' supply based upon the present production of one hundred thousand barrels daily.

In very much the same language used in the report of the Energy Resources Committee to the National Resources Committee it may be here observed. Proration to market demand carries with it primarily the idea of price. While price is important and production procedure is likely to be more economic and more in line with good production practices at $1.00 a barrel than at 20 cents a barrel, New Mexico's conservation measure is designed primarily to prevent waste. It may be effective in keeping price on a margin with the value of the product, but we must always remember that ineffective conservation of oil and gas resources will hasten the rise in prices which the agencies of commerce and other consumers will have to pay for their fuel. Furthermore, the rank of petroleum as a source of energy, its vital importance in national defense, its vulnerability to destructive forces in exploitation, and its comparatively small reserve in comparison with the high rate of withdrawal, place this commodity in an unique position among the natural resources. The welfare of the nation is so dependent upon a continuous and reasonably priced supply of motor fuel, lubricants, and other petroleum products as to demand the consideration of petroleum from the standpoint of national policy. This offers a sound basis for regulatory statutes directed at conserving this great natural resource.

The power to enact any such legislation, in my judgment, rightfully vests in the sovereign states only. But it is quite apparent that the problem of conservation has not been entirely solved by the healthy regulation of the petroleum industry in New Mexico and in those states that have adequate conservation laws. No state is now in exact position to protect itself from another state, and consequently no state can, in equity to its own industry, enforce regulations appreciably more effective than those of other states competing for the same market. Should the oil producing states fail now to recognize the immediate need of the hour—action on the part of all oil producing states that would bring about sound regulation and orderly procedure common to all said states—and should they fail within a comparatively short time to solve the problem the federal government is very likely to step in and control the marketing of oil.

The Supreme Court of the United States, two weeks ago, by its decision in the case of James H. Mulford, et al, vs. Nat. Smith, et al (known as the Tobacco Case), has paved the way for Congress to act. The following quotation is taken from the decision mentioned, the parentheses being inserted by the General Counsel for the Independent Petroleum Association of America in quoting from the decision mentioned in order to point out its applicability to petroleum:

> Section 311 is a finding by the Congress that the marketing of tobacco (petroleum) is a basic industry which directly affects interstate and foreign commerce; that stable conditions in such marketing are necessary to the general welfare; that tobacco (petroleum) is sold on a national market and it and its products move almost wholly in interstate and foreign commerce; that without federal assistance the farmers (producers) are unable to bring about orderly marketing, with the consequence that abnormally excessive supplies are produced and dumped indiscriminately on the national market; that this disorderly marketing of excess supply burdens and obstructs interstate and foreign commerce, causes reduction in prices and consequent injury to commerce, creates disparity between the prices of tobacco (petroleum) in interstate and foreign commerce and the prices of industrial products in such commerce, and diminishes the value of interstate commerce in industrial products; and that the establishment of quotas as provided by the Act is necessary and appropriate to promote, foster, and obtain an orderly flow of tobacco (petroleum) in interstate and foreign commerce.

Aside from such warning let us here in New Mexico keep foremost in our minds that, while production without any thought of a large ultimate yield, that is, wasteful production, may seem more immediately profitable than production controlled to secure more oil over a longer period;

the state, looking to the future of its tax returns, should recognize that, although under wide open production there may be a large tax fund immediately available, the total is sure to be reduced in the long run by the reduced ultimate production. Furthermore, the economic decadence of communities built on oil fields prematurely exhausted by wasteful methods constitutes a serious social problem.

To secure the benefits of a continuous stream of reasonably priced liquid fuel for as long a period as possible for the national defense, for the people as a whole, for all of the states, oil producing and non-oil producing, and to protect not only herself but those states that desire conservation against those considering only the immediate gain has been and still is New Mexico's concern.

If it can be said, which seems reasonable, that New Mexico has raised the level of her prosperity in that she has set an example for other states largely through the wisdom of her oil policy, it might be equally sound to suggest that these policies be continued if not enlarged. For one thing, it would appear rather pointless for any state, the progress of which is as largely dependent upon oil as is New Mexico, to dissipate her reserves by producing its oil fields inefficiently or above a reasonable market demand. Oil is a wasting asset. It is becoming increasingly difficult to find new deposits. Present figures for 1938 indicate that the estimated reserves in the new fields discovered in the United States were lower than the actual national production. The present conditions of over-capacity to produce will gradually disappear, and those states which have truly conserved their petroleum reserves will be well repaid for their forbearance. Allow me to express the hope that, if for no more than her own pecuniary interest, New Mexico will maintain her position in the vanguard of the conservative movement.

A SOUND CONSERVATION PROGRAM

By COL. H. B. FELL[1]

Petroleum was first produced commercially in the United States in the Drake well in Pennsylvania in 1859 and the industry has only assumed a position of the first magnitude in the past thirty years. The petroleum industry is today one of the largest and most important industries in our nation and serves the people with essential commodities. The well being of the petroleum industry is, therefore, of prime importance to the entire nation. Crude petroleum or reservoir oil is itself a mixture of hydrocarbons. Reservoirs of crude petroleum are widely distributed both geographically and geologically but are confined almost exclusively to sedimentary rocks. Oil accumulates where there is a suitable trap either structural or stratigraphic. It is generally associated with salt water and sometimes there is a free gas cap. The greater the gas pressure in the reservoir, the greater the amount of gas which is held in solution in the oil. The oil occupies the spaces in porous sandstones and limestones in association with gas.

Actual geological conditions are very complex with many unconformities, including complicated foldings and faults. There is great variation in the thickness of the productive horizons and the porosity and permeability of the productive horizons vary greatly.

The oil, gas, and water found in a reservoir are confined under pressure in a state of equilibrium. This natural pressure, or what is known as reservoir energy, is composed of the free gas under pressure, the gas in solution in the oil, and in the water or hydrostatic pressure against the oil on the flanks of the reservoir. The production of oil results from creating a point of lowered pressure in the reservoir. When a well is drilled and penetrates the strata overlying the reservoir and enters the reservoir, the pressure equilibrium is disturbed and the liquids and gases move through the pores of the sands to the point of lowered pressure. This lowered pressure permits the gas in the oil to expand and come out of solution and this expansion of gas in solution, together with the expansive force of the free gas and/or hydrostatic pressure of the water against the flanks, forces the oil through the formation to the well and up to the surface.

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When the components composing the reservoir energy have been depleted to such an extent that they are not sufficiently great to produce the oil by natural flow, pumps or other forms of artificial lift are installed and the lifting of the oil to the surface in that manner creates the pressure differential to cause the migration of oil to the bottom of the well. Of course, as the pressure in the reservoir declines, more dissolved gas comes out of solution leaving the oil thicker and increasingly difficult to move.

The total reservoir energy and the total volume of oil and gas contained in any oil pool are definitely limited. Oil in a pool is never exhausted. The reservoir energy is exhausted and the reservoir is abandoned. The amount of oil ultimately recovered from any reservoir depends primarily upon the proper use and maintenance of reservoir pressures. Wide open flow or too rapid flow results in rapid depletion of the reservoir pressure and lessens the ultimate recovery from the reservoir.

Crude petroleum is an irreplaceable natural resource essential to our present day economic life. While the estimated known reserves in the United States—15,000,000,000 to 17,250,000,000 barrels—are the greatest in the history of the industry, the supply is limited in the sense that no more is being created—at least rapidly enough for our consideration—and it is impossible to determine the amount of undiscovered reserves.

In view of the waste of natural resources in the past, the people of this nation, in general, now recognize the fact that it is detrimental to the ultimate welfare of this nation to waste any natural resource and that, accordingly, every effort should be made to prevent the waste of any natural resource and particularly those that are irreplaceable. I believe that a sound policy is "We can afford to use but not waste our natural petroleum resources."

Conservation should not be confused with reservation. Reservation means to hold back and refrain from use. It is perfectly proper for each generation to use the natural resources but it is not right for them to waste them. Products of crude petroleum can be secured from oil shales and coal, of which we have large quantities available, but at a materially greater cost.

Crude petroleum and natural gas differ from other irreplaceable natural resources in that they are migratory in nature, and, accordingly, more complex problems arise in developing a sound conservation program with reference to their production in such a manner that they will not only be conserved but that those engaged in their production will receive equitable treatment.

Under the law of capture, established in the early days of the petroleum industry, the crude petroleum from reservoirs became the property of the person reducing it to possession. This resulted in producers developing their properties as rapidly as possible in order to endeavor to get the greatest possible percentage of the oil produced from the reservoir. Each producer was forced, on account of the migratory nature of the resource, to do likewise and, as a result of this excessively rapid development and the open flow of wells, the reservoir energy previously referred to was grossly wasted and the recovery of crude petroleum from the reservoirs materially lessened. In addition to this, the excessive quantity of crude petroleum produced under this system from newly discovered fields necessitated the storage of large quantities of crude petroleum, and the products thereof, aboveground thus creating actual physical waste. It also resulted in economic waste due to the fact that this excess production depressed the price of crude petroleum at the well resulting in many instances in the premature abandonment of walls of small and settled production and it also resulted in economic waste resulting from the drilling of far more wells than were required to secure the greatest ultimate economic yield from the reservoir. Conservation includes the prevention of underground, aboveground, and economic waste. In applying conservation principles, it is essential that they be so applied as to provide equity to each producer of crude petroleum in the United States and, in determining the manner in which these principles should be applied, it becomes essential that each of the elements of waste be considered and balanced one against the others so as to secure a minimum of waste. Since crude petroleum is being produced from reservoirs in eighteen of the states of this nation and in view of the fact that no trade barriers can or should be erected between the states, it is readily recognized that the conservation principles must be applied in like manner to all the reservoirs or common sources of supply throughout the United States if a sound conservation program is to be made effective in a fair and equitable manner.

The purpose, naturally, of conservation is to provide the most oil for the least cost for the longest time. It should be clearly understood that this does not mean to produce the most oil for the least cost for the shortest time. Under such a program the objective is to recover the greatest possible number of barrels of crude petroleum from the existing reservoirs, and such reservoirs as may be discovered in the future, at the lowest average cost. It is the obligation of those engaged in the petroleum industry, and those having any regulatory powers in connection with the industry, to coöperate and work together in such manner as to most effectively accomplish the objective referred to. This objective can only be met by the reduction, to the greatest extent possible, of the three elements of waste that have been outlined. Practically everyone engaged in producing crude petroleum recognizes and is in favor of the application of sound conservation principles and is willing to be governed and conduct his operations in accordance therewith. There are, of course, a few, which is the case in connection with all human endeavor, whose interests are solely selfish and greedy and whose only desire is to get the most they can for themselves irrespective of the detrimental effect on others. It is largely for this reason that it becomes essential that conservation principles, to a large extent, be made effective through laws.

There are few basic principles that are, to my mind, essential to the making effective of a sound conservation program. Some of these principles are as follows:

1. In fields of small and settled production, known as stripper well fields where the reservoir energy has been depleted, there should be no restriction of production for there is no energy to conserve. Wells of this type must be permitted to produce their full production in order that the operator may receive sufficient income to keep the wells in operation, for otherwise it would be necessary to abandon such wells prematurely thus resulting in the loss of substantial known reserves. It is estimated at the present time that probably 79 per cent of the producing wells in the United States are wells of this type and that probably 40 per cent to 45 per cent of the known reserves of crude petroleum underlie these wells.

2. A producing well should have a minimum allowable daily production sufficiently high to provide, under normal price conditions, a financial return to the operator that will enable him to keep the well on production and prevent its premature abandonment. Such an allowable in many states is termed, in the conservation laws of such states, a marginal allowable.

3. The rate of flow from fields must be restricted to a maximum that will permit the effective utilization of the reservoir energy available in the field so as to prevent, to the greatest possible extent, waste of the reservoir energy and to secure the greatest ultimate economic yield.

4. Stocks of crude petroleum and its products should not, at any time, be in excess of those quantities required to maintain a continuous flow to the consumer and to provide against any reasonable contingencies that might develop.

5. There must be a permanent, assured, and effective balance of supply with demand. In other words the three elements of supply—imports, storage withdrawals, and domestic production—must not exceed the two elements of demand—exports, and domestic consumptive demand.

6. Provision must be made in law for economic spacing of wells in a pool. New Mexico wisely made such provision several years ago and, as a result, no operator is compelled to drill excess wells in order to obtain his equitable share of the production under proration from his properties. It is not economically sound to enforce proration or well spacing in a manner that requires an operator to drill more wells on his properties in a pool than are necessary to enable him to produce his pro rata part of the oil that is allowed to be produced from the pool for by so doing an unnecessary capital investment is forced upon the operator and thereby increases the cost of production.

7. In order to prevent premature abandonment of producing wells and the loss of the reserves of crude petroleum lying thereunder, so as to make possible the furnishing of the most oil at the lowest average cost, the price of crude petroleum at the well should be based on the average cost of producing oil from pumping wells.

Having now considered some of the fundamental principles of a sound conservation program, we are confronted with the vitally important question as to how these principles can be made effective and equitable conservation placed into practical effect.

The Bureau of Mines of the Department of the Interior of the United States government issues estimates, each month, of demand, these estimates being made and issued about the middle of the month for the following month. From observation and comparing the estimates of the Bureau of

Mines with the actual demand over a considerable period of time we know that these estimates have been surprisingly accurate so there is reason for assuming that the same accuracy will prevail in the future and the estimates of exports and total domestic consumptive demand can be used as an accurate yardstick to estimate total demand. The appropriation by Congress of the funds necessary to enable the Bureau of Mines to make these estimates should be continued indefinitely as an aid to the conservation program.

Being able, therefore, to have accurate estimates of the total demand, it then becomes essential, if the balance necessary to prevent waste is to be accomplished, that the total supply be limited to the total demand.

There are only three elements of supply, these being imports, stocks, and domestic production.

Currently imports, on the average, can be and are estimated rather accurately in view of the fact that the importers have been keeping imports down to an average of approximately 4½ per cent of total demand in view of the gentlemen's understanding that such an average was fair both to the importers and to the domestic producers. This situation, however, is only the result of voluntary action so, accordingly, is not definite and fixed. There should be a legal restriction of imports in the same manner that we have legal restriction of domestic production if a sound conservation program is to be effected, and, accordingly, the Congress of the United States, which is the only body having the power so to do, should enact legislation limiting and restricting imports of crude petroleum and the products thereof to not more than 4½ per cent of total demand, which includes domestic consumptive demand and exports.

A survey, made by the Bureau of Mines, of crude petroleum in storage in the United States showed that working stocks of somewhere between 205,000,000 barrels and 250,000,000 barrels of crude oil would be ample. It was, of course, impossible for the Bureau of Mines to set a definite figure on account of the different needs of the various units engaged in the industry. If these estimates of the Bureau of Mines are to be accepted, it would indicate that stocks of crude petroleum, which are now in excess of 276,000,000 barrels, should be further reduced. It should be recognized that irrespective of what estimates are made as to proper working stocks, so long as purchasers are willing and prefer to draw from storage rather than to purchase current production, the stocks are too high and should be reduced until such time as they have reached a level where the purchasers of crude petroleum will take current production rather than to withdraw from storage. That situation does not exist at this time, and, accordingly, stocks should be further reduced. There is no legal authority in existence to restrict or to require withdrawals from storage nor do I have any suggestion as to how this can be accomplished by law; however, withdrawals from or additions to storage could be controlled through the production allowables granted under the regulatory laws of oil-producing states if all oil-producing states had conservation laws and if imports were definitely restricted.

We know quite accurately the total demand, including exports and domestic consumptive demand. If the imports and withdrawals from or additions to storage are determined and deducted from the total demand we have the domestic production required to balance supply with demand.

At the present time, with the potential productive capacity of the wells in the United States in excess of the demand for domestic production, we find it necessary to restrict production in order to balance supply with demand.

This restriction of production has been termed "proration." Many people erroneously use the word proration when they mean conservation. Proration is entirely secondary to conservation and is merely a means under a conservation program of providing equity to the various producers concerned.

Irrespective of the demand, no pool should be permitted, under a sound conservation program, to flow at a greater rate than will permit the recovering of the greatest economic yield from that pool. It is easily conceivable that a situation can develop where sufficient oil could not be produced from reservoirs under a sound conservation policy to meet the demand.

Subject to reasonable and necessary practical limitations, proration rests upon the fundamental proposition that each producer each day, wherever his properties are situated, will receive his ratable share of the day's market and, with broad adjusting factors taken into account, will also receive the prevailing market price. This is of the utmost importance to the independent producer who is wholly dependent upon others for his markets and the transporting of his oil.

In order to effectuate this fundamental principle it is necessary to have adequate control of (a) fair and equitable allocations among the states; (b) fair and equitable allocations among pools within the state; (c) ratable takings within pools within the states.

There is no authority today to establish the feature of equitable allocations among states. Even were all agreed that the Bureau of Mines estimates should govern and were each state pledged to observe such demand figures as the basis for production allowables, there remains the fact that some states capable of producing in excess of such demand estimates have no laws which provide for restriction of production.

How this problem is to be met I shall not predict except to venture my opinion that it will be met. The Interstate Oil Compact Commission is giving this the most serious study of any question now currently before it. Despite its limited membership of only six of the oil-producing states, the compact has achieved much and with greater membership, which we have reason to expect will be brought about fairly soon, it will go much further in providing uniformity of production standards.

Other agencies than the compact commission are working on this problem of equity between states. Among them is the association which I have the honor to represent. Its Special Study Committee of Thirty-Six has been studying this and other questions which concern conservation and the welfare of the industry.

Some have suggested that equitable allocations among states be accomplished through the Interstate Oil Compact by extending the provisions of the compact to provide the necessary authority to make and enforce such allocations. Others have suggested that these allocations be made by the federal government, with authority, in case a state exceeds the allocation made to it, to prevent the shipment of crude oil, or the products thereof produced in the state, in interstate and foreign commerce. It is quite possible that other means of accomplishing this purpose may be suggested in the future. It is not my purpose to argue the advantages or the disadvantages of these proposals. It may be said that some of the opponents of federal regulations have relied chiefly on the belief that federal legislation to accomplish this purpose effectively would be held invalid by the Supreme Court of the United States as an unconstitutional invasion of the powers of the state. No one can predict, either with wisdom or propriety, what that court will do but the decision of the Supreme Court on Monday, April 17, in the case of James H. Mulford, et al, vs. Nat Smith, et al, which involved a federal law pertaining to marketing tobacco, would seem to remove more of the doubt as to the federal government's authority, leaving to the Congress now, more than ever, the question of the desirability of such legislation. There is no clear cut generally accepted answer yet to the question of fair and equitable allocations among the states but I do not doubt that one will come.

With reference to (b), fair and equitable allocations among pools within the states, there are provisions in the conservation laws of some of the oil-producing states providing that there should be no discrimination in purchases from the pools within a state. Other states having conservation laws do not have such provisions in their laws and we find, even in some states where the laws include such provisions, that these are not strictly enforced and that discrimination in purchases from pools within the state exist, thus preventing equitable proration and permitting selective purchasing.

After the total production from stripper wells and marginal wells has been provided for, the balance of the demand for the state should be equally distributed among the pools in the state in such a manner that there will not be discrimination in purchases between pools within the state and the allowable to each pool should be so limited that the rate of flow from the pool will not be so great as to prevent the securing of the greatest ultimate economic yield from the pool. Under such a policy there could not be special allowables for any pool, for the granting of a special allowable to a pool does bring about inequities and is contrary to the equitable provisions of a sound conservation program.

As to (c), ratable takings within pools within the states, it is clearly evident that this is essential if the correlative rights of all those within a pool are to be properly protected and if no owner is to have his property drained by offset wells that are allowed to produce at a rate greater than his wells. It has been assumed that the regulatory bodies in states having conservation and common purchaser laws can enforce ratable taking within a pool but it has been suggested that even these regulatory bodies may only possess limited power in this respect which is to say that some are of the opinion that if one purchaser in a common pool reduces his purchases then state regulatory bodies cannot affirmatively redistribute the remaining allowables on a ratable taking basis. It is also suggested that the regulatory bodies have no power at all over wells making less than the marginal allowable and in some states it is pointed out by some attorneys that the common purchaser laws are really not effective and that the ratable taking, as carried out, is actually voluntary action on the part of the purchasers. If these things to which I have referred are correct, it would then seem essential that the conservation laws and common purchaser laws of the oil producing states having such laws be amended in such a manner as to provide unquestioned authority to require ratable takings from properties within a pool and that states not having such laws should be certain in the enactment of their laws that this is properly taken care of.

I have endeavored to point out what, in my opinion, are the essential and fundamental principles of an equitable proration system under a sound conservation program. These principles have been violated continually in many areas, due, apparently, to the lack of any public authority empowered to enforce them. We have had, and have, proration of stripper wells, discrimination in purchases from pools within the same state, lack of ratable takings in the same pool, special allowables, and many other inequities in the carrying out of proration.

It, accordingly, becomes apparent that proration and conservation is somewhat of a paradox. We regulate production without any public authority which is empowered to see that equity and fairness and ratable takings are assured to all concerned and particularly to those producers who are entirely unable to protect themselves. No practical plan has been developed or made effective to provide control over all factors involved in a sound conservation program.

From my knowledge of your situation in New Mexico, I believe that you have one of the best oil conservation laws in this country and that it has been very efficiently and effectively enforced by your state regulatory body. The wide spacing for drilling in New Mexico has been an outstanding achievement in connection with establishing sound conservation for it has eliminated the necessity of the drilling of a lot of unnecessary wells and the unnecessary investment involved therein. One of the serious mistakes that have been made in applying proration in some states has been that, in allocating production, too great weight has been given to the potential of wells and too little to acreage. If less weight is given to the well and more weight is given to the acreage, great strides will rapidly be made in the eliminating of the drilling of unnecessary wells.

That unnecessary drilling—drilling more wells than are necessary to secure the maximum economic recovery—can induce waste has been demonstrated again and again. It is usually the case that the operator who is willing to drill on uneconomic locations is the operator who has no concern for conservation. He is ambitious only to recover his investment and make some kind of profit in the shortest possible time. That means volume production and that, in turn, means production under conditions of flow that produce waste of reservoir energy.

Obviously, the operator who drills one well on ten acres in a field where reservoir conditions are such as to make that the proper spacing, should not be held to the same allowable as the one whose well is, in theory, draining only one acre, or, stating it conversely, the one-acre well should not be elevated in allowable to the status of the ten-acre well. The sooner other states recognize spacing as one of the major components of well allowables, the sooner will we have this problem of excess drilling solved. Because of this problem we continue to commit waste, both physical and economic.

Most of the purchasing companies in recent months have been coöperating to the fullest extent in endeavoring to make effective the fundamental principles necessary to a sound conservation program and essential to the fundamental principle of fair proration. They can go a long way in doing this and they and the various oil producing states must realize that this public duty and obligation must be discharged fairly and equitably or otherwise either proration will fail or added federal assistance will follow or both will result.

A sound conservation program effectively and equitably enforced is to the best interest of all concerned. It should result in furnishing the consumer with the products of crude petroleum at the lowest average cost for the longest period of time and without wide fluctuations in price. It should delay the time when it will become necessary to go to other raw materials, such as oil shales and coal, from which to secure the products now secured from reservoir oil and from which the products can only be secured at a materially greater cost. It should provide a more stable price and a fair price for crude petroleum to the benefit of both the producer and the consumer. It should assure more permanancy and stabilization in the employment of labor in the producing branch of the petroleum industry at reasonable wages. It should result beneficially to those engaged in supplying materials and equipment to the producers of crude petroleum through providing a more stable and regular demand for such materials and equipment and thus assist in eliminating the peaks and valleys of industrial production. It should tend to stabilize our entire economic system.

I do not believe that there is any question but what the people of this nation are determined that their natural petroleum resources should be conserved and that the conservation program shall be sound, fair, and equitable. The recent report of the Energy Resources Committee to the President of the United States indicates the trend of thought of many in government services and undoubtedly of at least some portion of the public. How the program is to be administered will depend largely on the industry and the governments of the oil-producing states. The industry wants a sound and equitable program, properly and fairly enforced. Differences of opinion exist within the industry as to the proper procedure to accomplish this purpose. The oil-producing states naturally desire that the regulation be kept within the state. It is my opinion that they can keep it there if they will, but that the only way that it can be kept there is by a willingness on the part of the governments of each of the oil-producing states to have and to enforce fair and equitable conservation and common purchaser laws that will make effective the sound basic principles of conservation and proration and to join together, through the Interstate Oil Compact, in a coöperative movement that will provide for each producer in the United States his equitable share of the market.

The progress that has been made in the technique of finding oil and of drilling wells to almost any depth the operator desires to go has all been made in the last fifty years. That is not so long after all. I believe that it will require only a few of the next fifty years to gear our economics to our technology, and that development will come through coöperative action working together in the realization that the well-being of the petroleum industry is synonymous with the well-being of America.

DISCUSSION

By D. R. KNOWLTON [1]

Colonel Fell has covered the subject of conservation in a sound and complete manner. Being a production man, it is particularly gratifying to see his very fine treatment of the important subjects of reservoir control and economic spacing of wells. Proration and conservation are terms that are in general, greatly confused. The term "proration" unfortunately carries to many the implication of a penalty—some sort of unexplained restriction imposed upon the producer. It is unfortunate that this word has been so construed, and its long usage will probably eliminate the possibility of a change to a more appropriate term which would be "production control," or "reservoir control."

Colonel Fell also stressed the excellent conservation law in New Mexico and its intelligent administration. This is best illustrated by quoting from the last report of the Independent Petroleum Association of America on unnecessary and unprofitable drilling. The latest available allowable figures have been substituted so that the picture will be up to date.

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Forty-acre spacing has been used in a few areas in Texas, Oklahoma, Louisiana, and Kansas. In New Mexico allocation of allowable production for the most part is on the basis of 40-acre proration units without regard to the number of wells drilled on the unit. As a result, drilling has been limited, for the most part, to one well per forty acres, and the benefits of wider spacing can be shown clearly by comparing the statistical position of the industry in New Mexico today with what it would be had the wells there been drilled on the standard one well to ten-acre pattern.

At the present time all the newer fields in New Mexico have 40-acre proration units. For May, 1939, the allocation for 40 acres in these pools in New Mexico is 54 barrels daily. If these fields had been drilled up on a well-to-10-acre basis the allowable per well would be only 14 barrels daily, assuming the allowables to the pools to be the same as now, which seems probable. The pay-out status of these wells on 40 acres averages about three years, but would be lengthened to more than twelve years had the wells been drilled on a well-to-10-acre spacing pattern.

It then follows that New Mexico is in the best statistical position of any of the states due wholly to the far-sighted attitude of the operators and the regulatory body in that state. Many of the pools in other states that are feeling the "pangs" of proration are producing more currently per acre than are the wells in New Mexico. East Texas with an average of 5 acres per well densities and with the two Saturday and four Sunday shut-downs is producing 16 barrels per well per day or 130 barrels per 40 acres or approximately 2.5 times as much per acre as New Mexico. Western Kansas on 10-acre spacing with an average allowable of approximately 25 barrels per well on prorated wells, is producing 100 barrels per 40 acres or two times that of New Mexico. It then follows that if western Kansas had drilled their wells on 40-acre spacing they would now be producing 100 barrels instead of 25 barrels per well and east Texas on 40-acre spacing would be producing 130 barrels instead of 16 barrels per well. Countless other examples could be cited where real distress exists due to close spacing.

It has been conclusively found that under proper reservoir control where the oil is kept in a liquid phase in the reservoir and withdrawn at slow rates of flow, one well will drain many times the area that it would under old methods of open flow or greater rates of flow which allow the gas in the oil to come out of solution in the reservoir. In water drive or combination water and gas drive pools the encroachment of water can be so regulated by proper rates of withdrawal to materially increase the ultimate recovery from a reservoir.

In this connection, it must be borne in mind that operators should not be forced into uneconomic programs of development, especially when the number of acres one well will efficiently drain in any given reservoir depends so much upon the method of reservoir control and the rate of withdrawal. Much has been said during the past two years about the large overproduction of crude oil. Production in excess of market demand has, no doubt, actually occurred but there is a far more serious type of overproduction happening every day in many of our oil-producing states. This overproduction is the taking of fluid from a reservoir at a rate too high to permit the most efficient operation and the greatest ultimate recovery. Many authorities believe that if all pools were restricted to the most efficient rate of production, then there would be no excess crude oil above ground to disturb the existing markets. In a talk, "An Administrator's View on Proration," which Colonel E. O. Thompson gave before the American Institute of Mining and Metallurgical Engineers annual meeting held in New York in February, 1939, he dealt very ably with this important subject.

Colonel Fell, in his paper, states that the purpose of conservation is, ". . . to provide the most oil for the lowest cost for the longest time." To me this statement covers the entire objective in a few words. I want to expand on the word "cost" as used here, for the cost of producing oil is so very vital today. Ten years ago the cost of producing a barrel of oil was in the neighborhood of $1.25—today this figure is much lower but still is not low enough. Still lower producing costs are absolutely necessary for the industry to make a fair profit, for we cannot expect to receive much higher prices for our crude for many years to come. More scientific methods of operation must be utilized to the fullest extent and it is the duty of every oil-producing operator to lend a hand in helping solve this lower production cost problem. Those waiting for higher prices will not be able to meet competition and will gradually drop out of the oil producing picture.

To my way of thinking low cost operation can most effectively be solved by unit operation. Not only does unit operation afford the best opportunity for proper reservoir control, but it makes it possible to also use every known operating economy. Inasmuch as Colonel Fell did not go into the subject of utilization in detail and because of the importance of unitization or unit operation on the future of the oil industry, I would like to devote the balance of my discussion to a brief outline of the subject.

From a contemporary, realistic viewpoint, the real need today is for the promotion or selling of the idea of unitization with the admitted aim of making the entire industry "unit conscious."

It is not difficult to understand why, until the last ten or twelve years, operators were opposed to unitization. Oil men at this time were the most rugged of rugged individualists, and the wildcatter's gambling spirit was thoroughly instilled in them. From their very nature it can be seen that they would have no desire to exchange this game of chance with the possibility of big, quick profits for the stabilized business under unit operations. Considering this inborn gambling spirit; the fact that the price of oil was approximately $3.50 per barrel; that there was a ready market for all of it; that taxes were low, and that wells were shallow; it is not surprising that little thought was given to conservation and coöperation. The oil business was too busy making money. Few had time to consider the plan of unit operation, but the few who did consider it became staunch supporters of the plan, and when such men as Messrs. J. Edgar Pew, Judge W. P. Z. German, and W. N. Davis joined in thought with Mr. Doherty, many others were induced to listen.

Today the subject of unitization is not so controversial. The value of unitization can now be balanced in the scale of experience. During the past eight years we have made long strides, but we are yet far from the goal. Today we are well convinced that unit operation is the proper solution to our most pressing problems. Our clear-cut task is to voluntarily apply this good formula to the utmost. It is not only our task—it is our duty.

The earliest information as to the merits of unit operation comes from those fields in foreign countries where the government is the owner and leases its oil rights to one company on a concession basis. The operation of an entire pool by a single company presents the same situation as unit operation of a pool owned by more than one individual or company. The skeptics need only to look with an open mind at the results obtained in these foreign fields and in some of the few units in this country for overwhelming testimony of the success of unitization. At Talang Akar, in Sumatra, development started in 1921 and 20,000 acres was proved productive and developed mostly on a 40-acre spacing basis. The reservoir was purely a gas drive type and all gas was returned to the reservoir by means of a pressure maintenance system. Today 70 per cent of the oil in place has been recovered. All production has been flowed and now the reservoir is filled with gas which is used currently to flow wells in another pool a short distance away.

There are many outstanding examples of successful operation of unitization of all classes. Some of the principal unitized projects in Oklahoma are: South Burbank Unit, Lucien Unit, Keokuk Falls, Ramsey Unit, and the Billings Unit. Several of the more publicized units in other states are: Tepetate in Louisiana, Lance Creek in Wyoming, and the Van pool in Texas.

Unitization varies in the different fields in many respects. Indeed, the flexibility of the arrangement is one of the considerations which make it satisfactory. The A. I. M. E. Committee on Unit Operation has classified units as either "full units" or "near units."

1. The "full unit" is one in which the working interest is held by one party or by several parties in partnership, and likewise the royalty interest is held by one person or several in partnership. This means that surface boundaries may be disregarded, and the operator need only to be governed by the nature of the reservoir. It can be readily seen that this is the most desirable type of unit, not only from the standpoint of economical operations, but also from the standpoint of reservoir control. Foreign fields are frequently of this nature; the Temple of Solomon pool, in Persia, and the Talang Akar field, in Sumatra, are outstanding examples. South Burbank is also an example of this type of unit, the Osage Nation owning the entire royalty.

2. The "near unit" pool is one in which only the working interests are held as a unit but the royalty interests are several. Development and operations must be partially governed by the surface property lines. Though not as desirable as the "full unit," this is very satisfactory and is far better than competitive development. This type of unitization has become quite prevalent and has proved successful in a number of instances within the last few years. Units hereafter formed in pools now producing will probably be of this type because of the difficulty of unitizing royalty holdings. Oklahoma examples of this class are the Lucien, Ramsey, and Billings pools—all are also splendid examples of broadmindedness on the part of the operators in the determination of equities.

Another class might be added which is exemplified by the recent unit formed in Lance Creek, Wyoming. This plan is similar to other pools that have the working interests unitized and the royalties separate except that each operator continues to operate his own properties but the oil is pooled in a common "pot" and divided according to distribution of equities which had been agreed upon. This plan does not have the advantage of the most economy of operation.

Units can be, and generally are, classified as to purpose. Generally these purposes are (1) to develop and operate as a unit, (2) to use pressure maintenance on the reservoir, and (3) to carry out a secondary recovery program. Where the unit is formed in the early life of the pool, all of these will be employed to increase profits.

Today we are in a better position to advocate widespread adoption of unit operation. Until the last few years its proponents had only theory and arguments to support their contentions. Now they can go forth armed with examples and figures to substantiate their claims. We are constantly acquiring new information to add to that now on hand. Payouts on units are very gratifying. Balance sheets show that they ring the cash register.

Several years ago a new extension to the Burbank pool was discovered. The field proved to be a large one and a competitive drilling campaign was imminent. Fortunately, the operators owning the majority of the leases agreed upon a unitization plan, which eliminated the necessity of drilling a large number of unnecessary wells. At the time of the negotiations the argument most strongly urged regarded the saving in development costs and the additional ultimate recovery which would be made possible. It is that consideration which induced most of us to agree. In the old Burbank field only about 2,000 barrels per acre were produced before the wells were placed on the pump. To date in the South Burbank pool there has been recovered an average of 6,500 barrels per acre and every well that was flowing when it was first completed is still flowing. It is my prediction that when the story is told it will be not the saving of two and one-half million dollars in development costs nor the additional ultimate recovery, but the saving in lifting costs which non-competitive operation and pressure maintenance made possible that furnishes the most attractive argument for unitization.

The Billings pool will in time furnish overwhelming evidence of the superiority of unit operation. Likewise will the Tepetate pool, in Louisiana, Lance Creek, in Wyoming, and the Ramsey pool, in Payne County, Oklahoma.

In eastern Kansas and eastern Oklahoma, splendid achievements are being accomplished with the unitization of pools of settled production for secondary recovery purposes.

Despite the outstanding accomplishments that have been achieved, it is surprising and regrettable that there are yet many companies and individuals who are passive on the subject and are not using any initiative in bringing about unit operation.

The objections to unitization are, to my mind, shortsighted and often erroneous. The ones most frequently heard are: (1) That it forces the small operator out of business; (2) That it is an unlawful monopoly or a violation of the anti-trust laws; (3) That it retards progress by stifling initiative; and (4) That it is inadvisable, due to excessive amount of involved accounting procedures and exorbitant charges for overhead by the operator. Such objections are more fanciful than real.

It certainly is not true that unitization forces the small operator out of the picture. It is the general practice when forming the unit to name the party with the largest holdings as the operator of the unit. It is true that in pools unitized to date a large company has been the operator. But this is because the large operators have been more active in promoting units in fields in which they operate. One need only to look at a typical proration schedule to see that were all the fields unitized, the small operators would be operating their share of the units. Contrary to what the opponents of unitization claim, the man with limited resources would be in a much better position if his holdings were in a unit. The chance of profit in the oil business no longer justifies the speculation involved in individual operation. But a small, independent operator, with holdings in a good block of acreage, and a desire to unitize, can more readily get other independents and the larger companies to share the risk. In addition to this, the reduced hazards will increase his bank credit and put him in a better position generally.

Equally without merit is the contention that unit operation might be unlawful. If unitization is to be affected in any way by law, it will be to compel rather than to prohibit it. The agitation for compulsory unitization has subsided to a great extent, but failure to unitize voluntarily on a more widespread scale is being used as an argument for federal control of the industry.

The third objection is that it stifles initiative—that without the competition there will be no incentive to develop new methods or practices. There might be some basis for this belief, but it is my personal opinion that the oil men who have come through the depression and who are continuing to operate in this day of distressed markets and low allowables are not mentally lazy. I believe that under unit operation there will be more, not less, incentive for the application of scientific methods that will bring about greater progress. Several units are voluntarily producing less than the market demand for the purpose of scientific determinations. This would be impossible in a competitive pool.

The objection about accounting procedures can no longer be given serious consideration, for a review of the modern forms and present-day accounting methods, exemplified in the "Uniform Accounting Procedure" adopted by the Mid-Continent Oil and Gas Association in 1938, will convince anyone of the practicability of systems now in effect which, among other advantages, limit overhead charges to a minimum figure.

These objections are dwarfed when the advantages are considered. Messrs. Earl Oliver and J. B. Umpleby, two men of unimpeachable qualifications, have listed thirty-three advantages to the producer, consumer, royalty owner, and the general public. The twelve advantages which they say accrue to the producer are as follows: (1) less capital investment required, (2) lower development cost, (3) lower operating cost, (4) products would be made more responsive to the producer's needs, (5) increased acre oil yield, (6) increased gas value, (7) stabilized business, (8) an investment more readily salable, (9) more actual control over business, (10) more dependable crude supply for the other branches of the business, (11) saving on plant capacity, (12) saving on pipeline and storage tanks. These are actual advantages, important ones, and are above serious criticism.

The major differences between unit and competitive operation which vitalize these advantages can be summarized as follows:

(1) Fewer wells are needed, (2) maximum economy of operation, (3) reservoir control is made practical, (4) it tends to stabilize the market.

How are we going to proceed to bring about this new conception of production? The task is not an easy one. Someone very aptly stated the problem when he said, "We have conquered Mother Nature; now we have only to conquer human nature." This problem of promoting unitization is, in the main, a problem of persons. It is not surprising that there should be a difference of opinion as to the relative values of the properties to be contributed to a proposed unit. Of course it is discouraging when we are faced with the situation where an operator who has holdings in the pool takes advantage of his "nuisance value" to gouge those who are trying to perfect the unit. It is not only discouraging but it is unfortunate, for, in the long run, this operator will feel the effect of his conduct. But we should not be discouraged by the fact that division of equities is difficult. We should take an aggressive attitude and enter into these discussions with an open mind. Although we may feel when the deal is consummated that we have not received the share in the unit which the value of our properties warranted, we also know that because we have been willing to coöperate, we are now the owner of an interest in a unit which will pay far more ultimate profit than our individual holdings would have netted.

There are three principal fronts upon which the problem of unitization is to be attacked. By far the least difficult unit to form is the one which is formed by operators holding leases in an undeveloped block. In these cases, it is not difficult to arrive at a means of establishing and dividing equities. Generally in such a case it is satisfactory to divide the equities in direct proportion to the acreage contributed to the unit. It is, therefore, important that unitization should start with the land departments of the companies. If the land departments would fully realize the economies that the production departments could exercise under a block of acreage rather than scattered acreage, few, if any, scattered leases would be purchased unless a pre-arranged unitization of leases were brought about.

The unitization of properties in a pool of settled production, although not as easy an accomplishment as a unit of undeveloped acreage, is not difficult to consummate. When a field has declined to a settled production there are a number of determinable factors which can be used as a basis for distributing equities. Some of the principal factors are: the accumulated production to date, the present production capacity, the producing acreage, the water production, and the decline curve.

The difficult task is met when an attempt is made to unitize an area which is under development. At this stage there is only a limited amount of information available, and an agreement can be reached only by the broadmindedness and generous approach to the problem by those who are conscious that the benefits received from unit operations will far offset any loss which might be suffered by their failure to receive their accurate equitable share.

It is apparent that the oil industry, in order to make a reasonable profit at the present or slightly increased price of crude oil must drill fewer wells on wider spacing and substitute for this saving of wells a more efficient use of the reservoir energy. Where the natural energy is not sufficient to maintain pressures, outside energy in the form of gas or water should be employed to accomplish pressure in order to bring about proper reservoir control.

These necessary accomplishments can best be realized by unit operation or blocked acreage. It is inevitable that those companies or individuals that survive competition must resort to such conservation practices, and the sooner it is accepted the quicker will be our return to a sound economic condition in the industry, and thereby avoid the necessity of federal control.

CHANGING PERSPECTIVES

By W. R. BOYD, JR.[1]

Nearly four centuries have passed since the white man first settled that great expanse of the Americas which now is New Mexico. During the greater part of that period the Spaniards and those who came after them sought to develop wealth in the form of gold and silver, of copper and coal, of lead and zinc.

Metals were precious in those early days, gold and silver for their exchange and decorative values, the other minerals for their usefulness. Those were the days of travel by horse and by foot, and of labor with crude tools. Far later began the era of mechanical transportation and of the use of machinery, yet, even then, man's search for wealth in New Mexico's subterranean storehouse still was directed toward the solid minerals.

It was as recently as 1924 that the discovery of Rattlesnake field gave New Mexico its first commercially-productive oil pool. Subsequent developments have revealed that the settlers, in seeking only the metals, overlooked the richest treasure of all—the liquid mineral, oil. In the past fifteen years the production of oil has enriched New Mexico and its citizens to the extent of some $250,000,000, an amount which is more than one-half as much as the total income received from all the metals produced in this state in the past ninety years.

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[1] Executive vice-president, American Petroleum Institute, New York.

Today the value of crude oil produced by New Mexico's fields each year is more than double the value of all metals produced annually. It is greater even than the value of livestock, and of all farm crop production; in fact, it is equivalent almost to the value of total farm production both of livestock and crops.

Royalty payments on New Mexico's oil bring to land owners more money each year than is obtained by planting, cultivating, harvesting, storing, and selling the state's largest farm crop. Corn produces about $2,500,000 a year; oil royalties amount to some $3,500,000. In fact, the income from oil royalties alone is equivalent to about one-third of the cash income received by New Mexico's farmers from all they produce, with the single exception of livestock. And it may interest those farmers to know that these oil royalties bring into the state nearly twice as much money as A. A. A. farm benefit payments.

Certainly New Mexico's interest in the great American petroleum industry transcends the academic. Here is a direct, economic, money-in-the-pocket participation in the proceeds of private enterprise as applied to industrial operations. To be specific, the value of one year's output of crude oil from New Mexico's wells amounts to an income of $248 for each family in the state. And perhaps it should be pointed out that the people of New Mexico never have been asked to subsidize through tax payments, or in any other way, the capital investment which had to be made before they could share the income. This is no unimportant fact to consider in these days of governmental spending, of forcing states to match federal expenditures, and otherwise to tap the family pocketbook.

You are interested in your petroleum industry in still another tangible, practical way. Yours is a state of vast distances. Here you have something like 185 acres of land for every resident. Under such conditions, you have had a serious problem of communication and of transportation, which never approached even a reasonable solution until the advent of the motor vehicle. Today, in traveling these great distances in your state, you put your motor vehicles to more intensive uses than do the citizens of most other states. Last year, for example, New Mexico's motorists consumed about 42 gallons—one full barrel—more motor fuel per motor vehicle than did the motorists of the largest gasoline-consuming states—California, New York, and Pennsylvania. The statistics indicate that the average New Mexican motorist drives his car approximately 600 miles farther per year than does his neighbor in California, and his motorist friends in Pennsylvania and New York.

Motor vehicle travel means so much to New Mexico that its people obviously have a direct economic interest in the extent of the future supply of motor fuels and lubricants, and in their continued availability at prices which not only permit, but encourage, the fullest possible use of the highways. You are interested not only in the availability of the motor fuel supply, and the cost, but you are interested financially in motor fuel taxes. Already your motorists are paying in special additional automotive taxes about one-third of all the tax revenue received by your state. The greater proportion of this income is derived from taxes upon motor fuel. In some cases you are paying three taxes on each gallon of gasoline you buy, one to the federal government, one to the state, and one to the community. Furthermore, I fear you will find, if you will take the trouble to ascertain, that these multiple levies tend disproportionately to increase the cost of motor fuel to the consumer and, to that extent, discourage the use and development of the highway travel upon which the welfare of your state is so greatly dependent.

While the low prices at which motor fuel has been sold in recent years may provide an excuse of questionable logic for excessive taxation, little excuse of any kind may be found for the tendency to divert to general purposes the income from taxes levied to build and to maintain roads. Fortunately for you, in recent years your state has been spending its highway tax income for highways, but the hopeless, heartless diversion of road funds by communities constitutes a problem which merits study. The oil which you produce in New Mexico, and the motor fuel which is made from it, can—if the taxes imposed upon it are reasonable and if the income is properly used—contribute much to the development of an adequate system of highways and thus directly to the greater welfare of your state and its people.

This is true particularly because changing perspectives have cast oil in an important new role, not only in New Mexico, but everywhere in the United States. Oil has become the lifeblood of our machine age. This liquid mineral, unknown to and unwanted by the settlers, has become a commodity so essential that its utilization is necessary to the fullest economic use of all we produce today. Yet one of the chief worries of those inclined to worry, either for public consumption or political advantage, has been concerning the adequacy of the nation's petroleum reserves. In fact, these official worries sometimes have served as the basis first, of increased taxation upon petroleum and its products, and, second, of agitation for the complete control of the petroleum industry by government.

In view of this situation, time should be taken for an informed, dispassionate, practical discussion of the reserve situation. Perhaps the situation respecting petroleum reserves in New Mexico would be suitable for such discussion, not only because it is typical but because it indicates so clearly how needless is alarm over immediate shortage.

Indications now are that, as of January 1, 1939, only four states had known reserves of crude oil in underground storage which were larger than those of New Mexico. New Mexico's oil, known to be recoverable by present methods of drilling and producing, is estimated at 703,200,000 barrels. This is nearly two and one-half times as much as has been produced in New Mexico since the discovery of oil here in 1924. It is about twenty times as much as the state is producing annually.

Estimates of New Mexico's oil reserves have been increasing steadily from year to year. On January 1, 1938, for example, such reserves were estimated at only 541,000,000 barrels. During 1938 some 35,000,000 barrels of oil were produced, yet by the end of 1938 sufficient additional supplies had been found to warrant raising the estimate of available reserves to 703,200,000 barrels. This is a net increase for the year of more than 192,000,000 barrels, including the year's production.

The petroleum reserves of the entire United States are estimated as of January 1, 1939, at better than 17,000,000,000 barrels, the greatest in history. This estimate will have to be revised to a higher figure, both because of the discovery of additional fields and the compilation of new and more detailed information concerning the extent of fields now in production. Never before in the history of the American petroleum industry have we been more certain, nor have we had more convincing evidence, of the definite postponement of the day of ultimate exhaustion of the oil supply.

Each day is extending man's knowledge of the origin and of the sources of oil. Each day the petroleum industry is becoming more proficient in discovering and in developing oil fields. Furthermore, we find no little comfort and assurance in the fact that, even should the day of exhaustion come within the next few generations or centuries, methods now known and used will permit the development of supplementary and substitute sources of supply without causing any serious economic problem, much less a crisis.

Unfortunately, the uninformed are inclined to divide the estimate of total reserves by a figure indicating annual production or consumption and to use the result as a measure of the number of years between today and ultimate exhaustion. For instance, it has been pointed out that New Mexico's petroleum reserves currently are estimated at twenty times the annual production. This does not mean, however, that New Mexico's resources will be exhausted in twenty years any more than the fact that the nation's annual oil consumption approximates one billion barrels means that the estimated 17,000,000,000 barrels of reserves will last only seventeen years.

It is true that if present producing fields were not extended in area, if no new discoveries were made, if exploration should cease, if progress in the technique and efficiency of oil recovery were halted, if the remarkable advances in the efficiency of refining should be eliminated, and if all our newly-developed information as to how to restore old fields to production and to perpetuate the producing life of the newer areas were lost—then we might face the fact that our oil supply definitely is limited. History has demonstrated beyond question that these are utterly improbable suggestions. The trend is definitely in the opposite direction. Our problem now is, and for years will be, one of dealing effectively with a sufficiency rather than a shortage.

The reasons are not far to seek. Successful exploration for new oil producing areas never has halted since the first commercially productive oil well was brought in back in 1859 in the hills of Pennsylvania. Never have petroleum scientists, technologists, and engineers been satisfied with generally-used methods of producing, refining, transporting, storing, or using petroleum and its products, but always have sought greater efficiency. Never has the industry paused in the work of developing more and better knowledge of oil, its origin, its sources, it availability, its use, and its possibilities. All along the line from production to consumption, men and methods have been changing, and are continuing to change, our perspectives in the petroleum industry. All these efforts, all this study, and all this progress adds to the sum total of definite assurance that we have no fear for the morrow.

We are finding oil today where, men said, a few years ago, it could not exist. We are producing oil today from pools which men said, a few years ago, were completely exhausted. The progress we have made in petroleum refining has worked for such great efficiency that we can meet, and are meeting, the nation's demand for refined petroleum products from a constant decreasing amount of crude oil. Completely have we changed our perspective of the use value of a barrel of crude oil. One barrel of oil today performs work which required the consumption of three or four barrels only a few years ago. Furthermore, by improving the efficiency of oil-production and reducing the waste, we are able virtually to drain dry oil sands from which, only a few years ago, we could obtain only one barrel of oil of every four available.

It has been pointed out that these are the days of alarms; alarms frequently artificial of creation and inspired of source; alarms which have done more to make us a nation of jitterbugs than all the swing bands in radio. Recently some of the alarms over oil shortage have been coupled with the suggestion that an industry producing so essential a commodity as oil should not be entrusted to private enterprise. Word pictures are painted of the alleged waste, inefficiency, and failure of private enterprise, and the proposal is made that the American petroleum industry be turned over to the federal government for operation, control, or, at the very least, close supervision.

Americans, traditionally, are proud of their federal government, but it may be doubted if even the most ardent patriots would care to support the argument that the federal government is, or ever has been, a model for successful achievement, efficiency, and effectiveness of operation, or elimination of waste. Overlooking, entirely, such highly important questions as states' rights, it would seem sufficient to say that the operation of an industry, or of industries, by the federal government is decidedly at variance with the American tradition and the American idea, past or present.

There is much to say about the operation of industry under private enterprise; over private enterprise alone do the citizens of the United Staets exercise personal and direct control. Let the customers become dissatisfied with a business enterprise, and no four years or eight years must pass before a change of administration, and a decided change in conditions, become effective. It may not be difficult to deal with a million dissatisfied voters, but let a million customers become dissatisfied, and things happen.

If we view the situation from the standpoint of results, there is a real question as to whether any government could have contributed more to the welfare of the American people in operating the petroleum industry than that industry has contributed, and is contributing, of its competitive volition. Consider the results: Never have we been even annoyed by a shortage of petroleum and its products. These commodities everywhere are available at prices consumers can afford to pay. The quality and usefulness of these products have improved through the years. Petroleum reserves now are at a record peak; technological progress is continuing; the customer has learned by experience to expect from this industry everything to which he is entitled, and more.

These remarks should not be interpreted as meaning that the petroleum industry is opposed to the interest of the federal government, or of any other form or branch of government, in its operations and undertakings. This industry repeatedly has demonstrated its eagerness and its willingness to coöperate with government for the greater welfare of the American people. But there is a vast difference between helpful coöperation and the insistence of some government officials that this industry be put under the wing of the politician.

The petroleum industry is not asking for control; it is asking the federal government, and the governments of oil-producing states, to fulfill the duties of government by accomplishing for the industry only that which the industry cannot do for itself. Coöperation with, rather than the operation of, industry should be the function of government.

By modern methods, oil can be produced with remarkable ease, at reasonable cost, and in enormous quantities.

In fact, production has become so efficient that it would be possible to increase the output greatly within a few hours. Refinery capacity is such that the output of refined petroleum products can be stepped up almost overnight to the point of making storage facilities completely inadequate.

This knowledge is comforting to a nation occupying an outstanding position of importance in a world trembling with fear of war. Oil has become an essential of war because of the extensive mechanization of armed forces and the complete transformation of the world's navies from solid to liquid fuel. Our facilities for production, refining, and distribution are such as to assure an America mobilized for war, of the only really adequate supply of oil and oil products in the world.

Unfortunately the non-competitive elements of the industry view these possibilities chiefly as excuses for producing as much crude oil and refined products as rapidly as they can without regard for actual need. The "Rule of Capture," which dates to the beginning of the industry, confers the ownership of crude oil upon him who first reduces it to possession. Since oil is migratory, and flows from one well quite as readily as from another, the discovery and development of a new oil field is likely to be a race for possession, which is to say, a race in production. This spirit of competition carries over into the refining branch of the industry, with new plants built, and established facilities forced to operate on schedules forced by the flood of crude from the fields, but justified by no consumption demand.

This competitive spirit encourages not only the drilling of unnecessary wells, the building of unnecessary refineries, and the operation of productive capacity to an excessive extent, but, to a large degree, the unsound expenditure of money, time, and effort. The producing life of oil sands is curtailed by unwise development. There is likely to be a hopeless, useless waste of reservoir pressures which otherwise might have been preserved and have aided in assuring complete recovery. Worst of all, perhaps, is the forced necessity of providing aboveground storage for oil and its products which, in the light of present knowledge, more efficiently, cheaply, and safely might have been left in natural storage underground. Finally, substantial economic loss is sustained all along the line because flooded markets result in so serious a depression of prices of consumption goods that no part of the industry, from the land owners to dealers who put motor fuel in the tank of the family car, obtain the reasonable economic rewards to which their services entitle them.

In an effort to improve this situation, the petroleum industry has sought the aid of the state governments in establishing some rational, reasonable, and effective form of petroleum conservation. In some quarters, these efforts have been interpreted as attempts to increase prices, but in view of the fact that reasonable prices are traditional in this industry and of the additional fact that the industry's welfare directly is geared to the widest possible utilization of its products, such charges scarcely are tenable. Rather, the industry is endeavoring, with governmental coöperation, to establish such a rational basis of operations as will permit it to operate under reasonable normal conditions in all its branches and in every part of the United States.

To this end, the industry itself has asked the government of oil-producing states to exert their authority in bringing about the orderly development of oil fields, chief source of the industry's difficulties. These efforts were begun as early as 1926, and there has been encouraging progress despite the handicaps of opposition within the industry and from some state governments, of adverse court rulings, and of conflict with anti-trust laws.

In recent years, sincere effort has been made, through the agency of the Interstate Oil Compact Commission, to bring together for discussion, study, and recommendation the respective states' authorities empowered to deal with petroleum conservation. New Mexico's officials have been conspicuous in the activities of the Interstate Oil Compact

Commission. Also, New Mexico has been a leader among the states in the enactment of what has been called the "Model Conservation Law." New Mexico, Colorado, Illinois, Texas, Kansas, and Oklahoma now comprise the oil-producing states which are signatory to the Interstate Oil Compact pledged to coöperative action in enacting laws designed to prevent the physical waste of crude oil and of natural gas.

In still another way the industry has sought to encourage and to assure the orderly development of newly-discovered oil producing areas. This method is known as voluntary unitization. It permits all interests in the new pool voluntarily to coöperate in its development and operation as a single property. In some cases development is undertaken by a single agency, or trustee; in other pools, separate holdings are developed in accordance with a generally accepted plan. The strucure of the area is studied, decision is reached as to how best development may proceed, and then the plan is put into effect by drilling only such wells as are necessary on those sites where scientific research has demonstrated drilling will assure the most complete recovery. Once a field is producing, all interests share in the output.

No mystery should surround the petroleum industry's interest in promoting petroleum conservation, nor in protecting and preserving the nation's future supply. Oil is this industry's stock in trade. Whether there is a great sufficiency of oil, as the most informed minds now believe as the result of the most accurate study humanly possible, or only a limited reserve as some political minds would, for one reason or another, have the American public think, there is no reason for excessive production; no reason for doing other than maintaining and extending the reserves.

This whole situation is well understood by some officials of the federal government and of the governments of some of the oil-producing states, as well as by the petroleum industry itself. Every investigation of the industry—and it has been investigated on the average of once annually for more than a decade—clearly has revealed all the conflicting factors, and has pointed the way to improvement. Possibly the only interest unaware, or unconscious, of the general situation is comprised of the American people. However, for their benefit, it can be stated understandably that the industry's efforts at conservation are designed to preserve and to perpetuate the nation's petroleum reserves to the end that present generations and the children of present generations may enjoy the blessing and advantages which accrue to the nation possessing an adequate, properly developed, and economical supply of oil and its products.

In view of the oft repeated charges that the industry, through its promotion of conservation measures, is engaged in a conspiracy to protect monopoly, to establish high prices, and otherwise to create a selfishly beneficial and artificial situation, this explanation may be startling in its simplicity. It is obvious to the American petroleum industry that its hope for economic security in the future, as at present, lies in doing exactly what it is endeavoring to do—provide the greatest number of people for the longest possible time at the lowest possible cost with an adequate supply of petroleum and its products at prices which encourage use.

It is obvious also that the industry's interest closely parallels the public interest. And it should be obvious that if the industry is to fulfill these ambitions, which really are its obligations, it should enjoy reasonable freedom of action, initiative, and flexibility of operations. Effective petroleum conservation fundamentally is a scientific, not a political, problem. If any doubt that statement he may find all the necessary supporting evidence by studying the results of the development of petroleum resources by political control, as in other countries, and comparing them with the situation in the United States and with the social and economic contributions of the American petroleum industry as a private enterprise to the national economy.

If the student of petroleum development will persist in his research he will be able to detect the almost exact correlation between the extent of use of oil and its products and national standards of living. Further, he will be able to find a convincing comparison between the rapid progress made in those industries which have enjoyed reasonable freedom of enterprise and the static condition of those industries which have been subjected to rigid political control. And finally that student, if he be seeking truth and facts, will be forced to the conclusion that the petroleum industry's record of successful achievement and of economical and efficient service to the American public, points the advisability of permitting industrial enterprise to continue its progress and of restricting government interference and control to those fields in which industrial enterprise lacks power and authority to be fully effective.